AN INDUSTRIAL PUBLISHING CORPORATION MAGAZINE

APRIL, 1959

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Precision Metal Molding

PMM

INCLUDING DIE CASTINGS MAGAZINE

DIE CASTINGS

EXTRUSIONS

INVESTMENT CASTINGS

PERMANENT MOLD CASTINGS

PLASTER MOLD CASTINGS

SINTERINGS

SHELL MOLD CASTINGS

WHERE TO BUY YOUR SINTERINGS

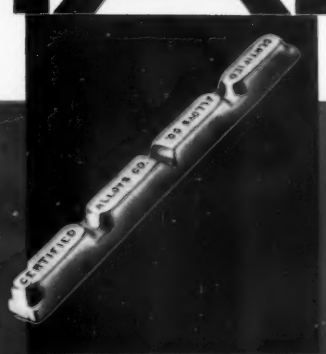
8th Annual

Powder Metallurgy DIRECTORY

UNIFORM HIGH QUALITY

ZAMAK

ZINC BASE DIE CASTING ALLOYS



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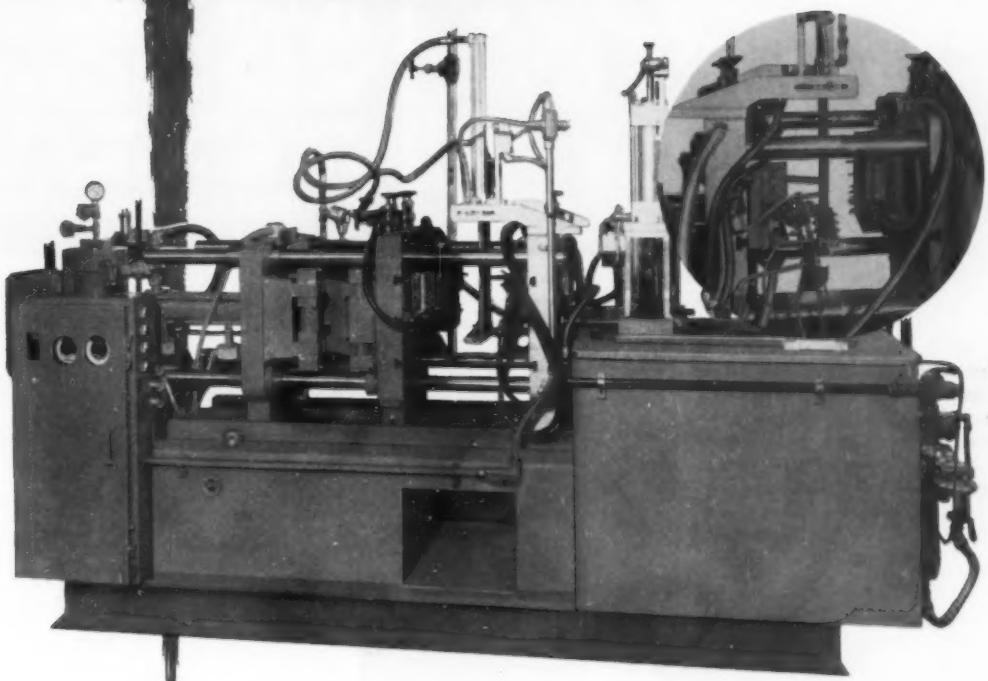

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We back up our claim to quality aluminum ingot with these three complete laboratories

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IN THIS ISSUE

April, 1959: Volume 17 Number 4

COVER

THE EIGHTH ANNUAL directory of the powder metallurgy industry is presented with this issue. As in previous directories, this one lists all of the custom fabricators of powdered metal parts, the suppliers of metal powders and the equipment builders. Every effort has been made to make this directory as complete and as useful as possible; it starts on page 61.

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By replacing bronze sand castings with aluminum extrusions, high tooling costs and excessive set-up charges were eliminated.

30 **HEAT TREATMENT OF SINTERED IRON**
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32 **DESIGN WITH NON-FERROUS SINTERINGS**
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36 **PROPERTIES OF DIE CASTING ALLOYS**
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A spray gun nozzle tip for abrasive materials was a big headache which was cured by substituting an investment casting for tool steel.

52 **RESEARCH & DEVELOPMENT INSTRUMENTS**
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115 **CAST HARDWARE LOOKS GOOD, WORKS GOOD, FITS GOOD**
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shotgun shot

BADLY FORMED AND MIXED IN SIZE, WOULDN'T WORK WELL IN GUNNING.

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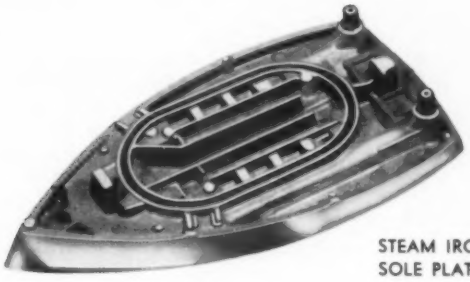
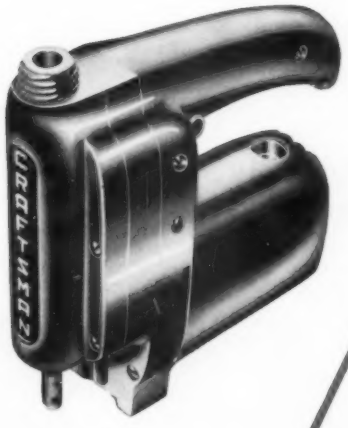
in the New York Metropolitan Area—combining automatic ladling with vacuum die casting to produce better quality castings at lowest possible cost!



STEAM IRON SOLE PLATES



SABRE SAW

Premier now brings the ultimate in quality vacuum die castings at the lowest possible cost.

Premier by combining automatic ladling with its vacuum die casting system has increased its production cycle, thus creating a tremendous savings.

Shown are typical vacuum die castings (we produce steam iron sole plates for six leading manufacturers).

If you are interested in getting quality vacuum die castings at lower costs send us your prints for quotes and compare—or

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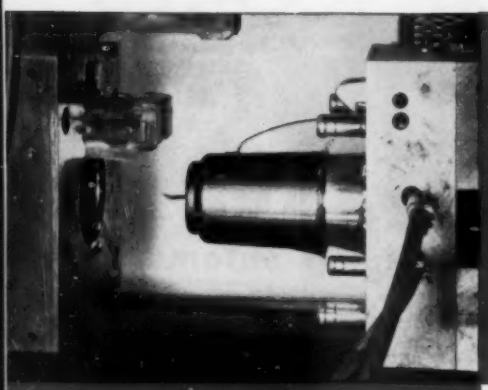
names that mean

"*First Quality Guaranteed*"



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for
plastic molds
and die casting dies

MC

The Mold and Cavity die steel made with particular care to permit blemish-free, highly finished surfaces. Furnished heat treated to 300 Brinell or annealed. Very deep hardening —uniform throughout large sections. Very low movement when oil quenched. For lower finishing costs and longer die life, use MC!

Speed-Cut

Free-machining at 300 Brinell. Choose Speed-Cut for economy in producing backing plates, cavity plates, spacer blocks and other plastic die parts. And when you must avoid *all* movement, machine Speed-Cut after hardening—with ease!

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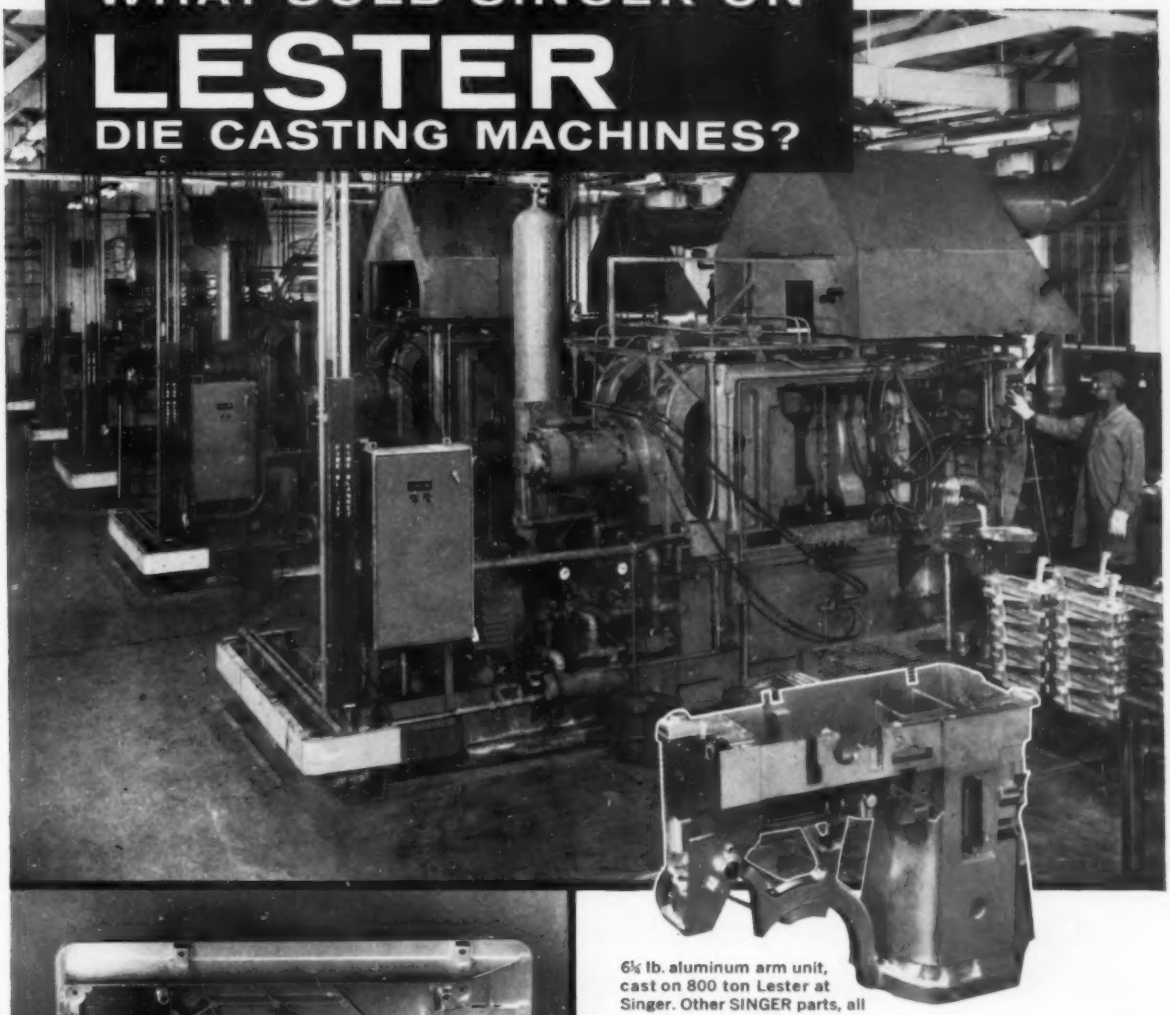
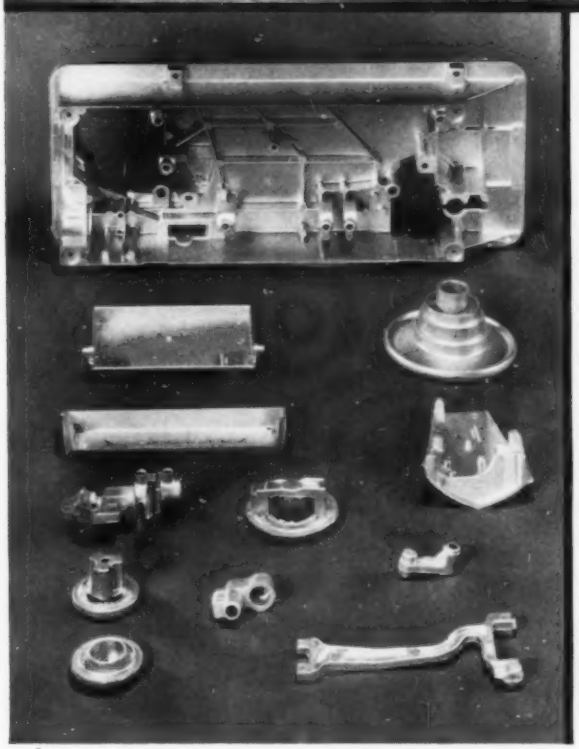
WHAT SOLD SINGER ON LESTER DIE CASTING MACHINES?





6½ lb. aluminum arm unit, cast on 800 ton Lester at Singer. Other SINGER parts, all cast on Lesters, shown at left.

What sold SINGER on Lesters? The basic rigidity of the one-piece frame which can be depended upon to tightly lock and keep locked even the largest of their dies, the main arm unit for their new model #401 SLANT-O-MATIC Sewing Machine. With this dependable clamp, they obtain consistent production of quality castings, with finish and density they have been otherwise unable to obtain.

As a result, Singer has installed 15 Lester Die Casting Machines of 800 ton and 600 ton capacity in their plant in Elizabethport, New Jersey.

Detailed information on Lester Die Casting Machines is available by writing...

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Agents in principal cities throughout the world

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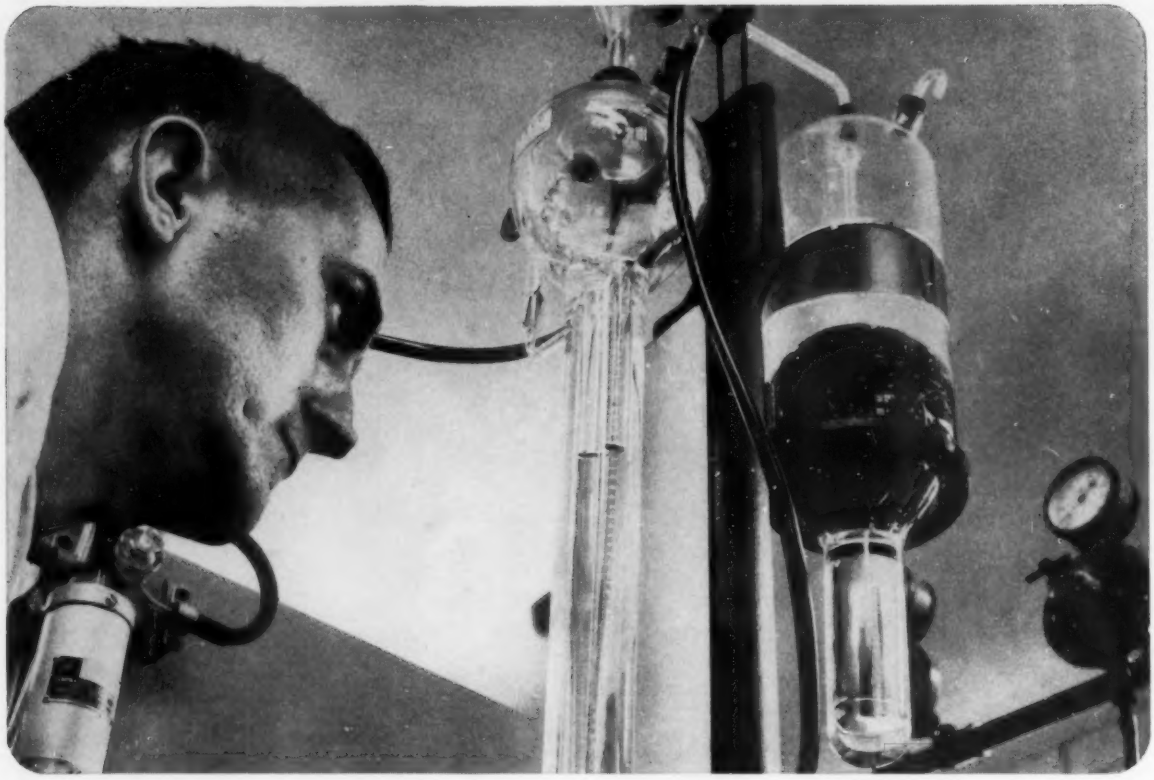
***Experience**—the added alloy in **Allegheny Ludlum** tool steels*



QUICK, FAST TESTING for carbon content is done not once or twice but 8 times per melt in A-L's Chem Lab with this direct reading Leco carbon determinator.

Carbon content checked 8 times during melt to guarantee A-L tool steel hardenability

Lab tests for carbon eliminate your guesswork; provide high hardness, uniform hardenability, reproducible tool performance.

Because carbon has the greatest influence on hardenability, Allegheny Ludlum watches it carefully during the melt. Testing a specimen for carbon takes only a few minutes. Therefore, A-L checks for carbon content 8 times during the melt, and makes the necessary adjustments to insure accurate control of carbon. This control means Allegheny Ludlum can hold carbon content to a closer range than most customers specify.

Carbon control at Allegheny Ludlum assures you of precise response to heat treating. This control in the melt brings you predictable, *high hardness, uniform hardenability* and *reproducible tool performance.*

This is just one of the many things A-L does to insure high quality. Here are some others: close control over forging techniques, rigid temperature-time programming, careful testing of billets prior to processing to insure good surface and sound interior, control over annealing to give you the right hardness for your exact machining operation, thorough metallurgical testing to insure top tool steel quality and meeting of your specifications.

Allegheny Ludlum stocks a complete line of tool steel sizes and grades. Call your nearest A-L representative; you'll get quick service and counsel on such problems as heat treating, machining, grade selection, etc. Or write for A-L's publication list which gives full data on the more than 125 technical publications offered. They'll make your job easier.

ALLEGHENY LUDLUM STEEL CORPORATION, Oliver Bldg., Pittsburgh 22, Pa. Address Dept. PM-16

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Tool Steel warehouse stocks throughout the country... Check the yellow pages

every grade of tool steel... every help in using it

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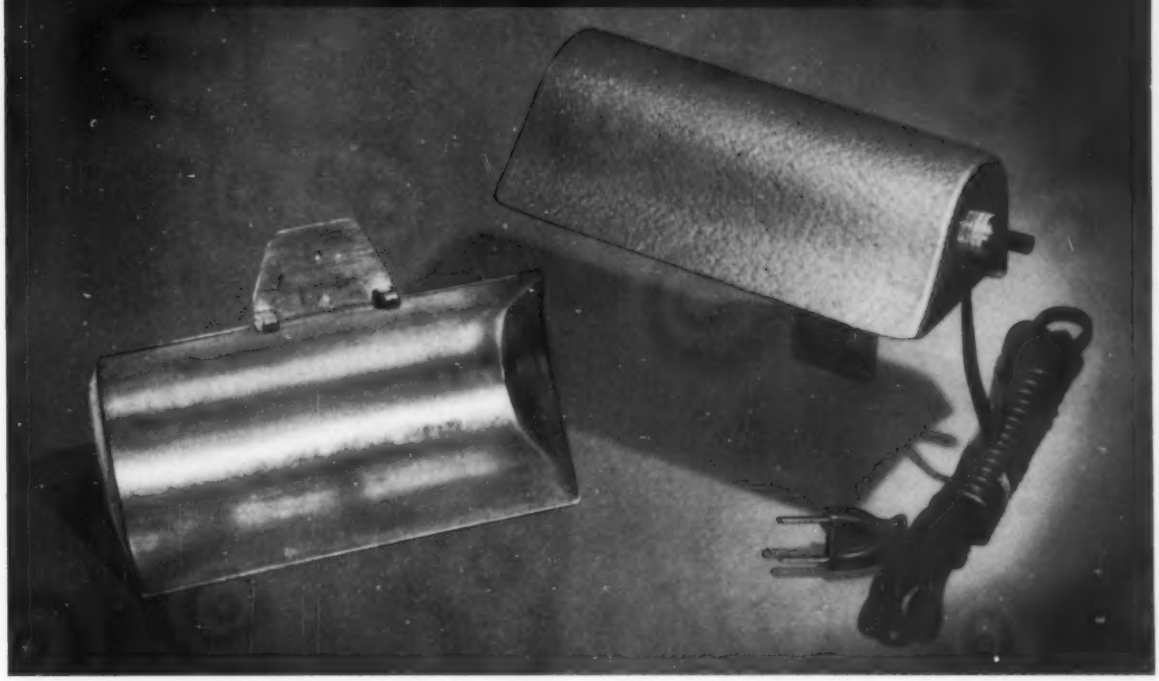
IT'S LIGHTER THAN YOU THINK!



AND EASY TO ASSEMBLE WHEN DIE CAST WITH... ZAMAK

The shade for this new KLIP-LITE* music stand is made of a single thin-wall zinc die casting—for light weight and low-cost assembly. As thin as a stamping but with far greater rigidity, the contours could not be duplicated in sheet metal.

By designing for die casting, only 4 holes are needed before spray finishing and assembling the socket-switch and mounting bracket.

These extremely thin wall sections—possible only with ZINC die castings—minimize weight and are stronger in proportion to thickness than heavier sections.

Parts designed for ZAMAK alloy die casting will meet competition of either stampings or aluminum castings—and at lower cost.

*Made by WIESE MANUFACTURING COMPANY—Davenport, Iowa.

THE NEW EDITION OF "THE END USES OF ZINC DIE CASTING"

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HORSE HEAD® SPECIAL ZINC AND HORSE HEAD ZAMAK ARE PRODUCED BY

THE NEW JERSEY ZINC COMPANY

DEVELOPERS OF THE ONLY STANDARD ZINC DIE CASTING ALLOYS IN USE TODAY

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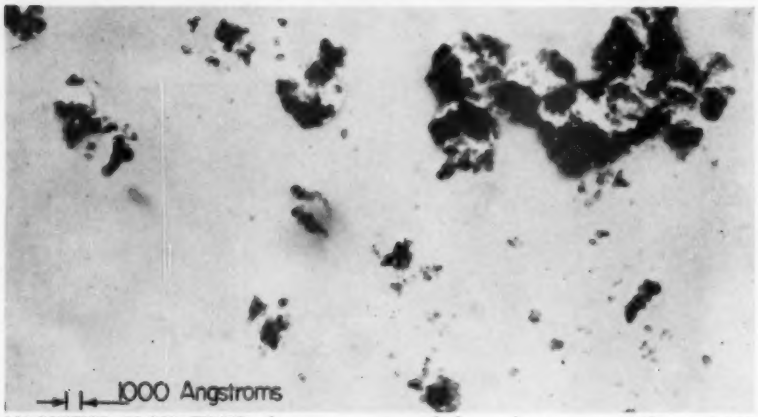
CASTING ABOUT

technical news of applications & processes involving precision metal moldings



MAGNIFIED 50,000 TIMES, the average size of these aluminum particles is 0.103 microns (range from 0.005 to 0.06 microns). The smallest generally available aluminum powder averages from 6.0 to 10.0 microns.

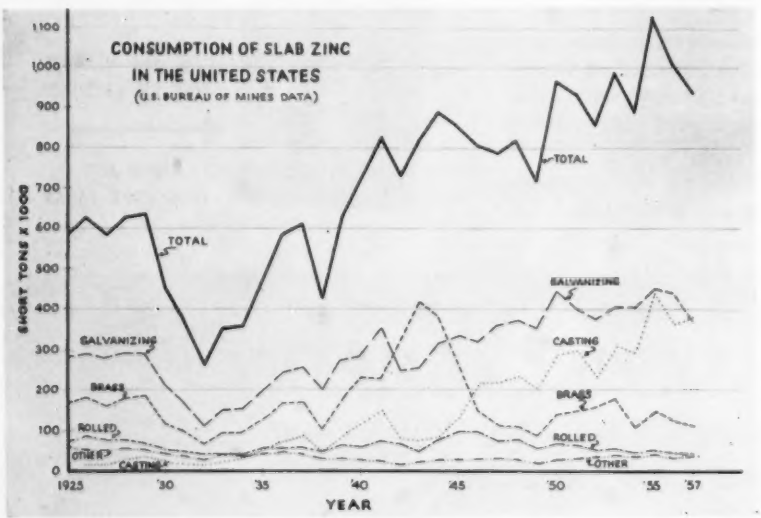
SO FAR, ONLY ALUMINUM powder is contemplated for production, but both iron and nickel powders have been made in the same size ranges as aluminum. As normally produced, the ultra-fine aluminum powder is phrophoric and is shipped in sealed containers under n-heptane or some similar organic liquid. However, a partially oxidized form is available which is not pyrophoric.

about one-millionth of an inch in diameter and with surface energy many times that of normally produced metal powders, new, ultra-fine metal powders are now being produced in experimental quantities by National Research Corp.

Because of the much higher surface energy and the far smaller particle sizes, rates of solid diffusion in powder compacts may be greatly increased so that more nearly homogeneous sintered parts can be produced than are now possible. Also, these new powders give some promise of opening entirely new and different compositions than have previously been possible.

VACUUM STREAM DEGASSING is proving to be the most practical method of hydrogen removal from large tonnages of steel. It promises to eliminate, in some cases, and drastically reduce in others the cost of heat treating. Dissolved hydrogen is the culprit in many cases where failure of steel parts has occurred under conditions of high stress, particularly on high speed rotating machinery and heavily stressed tool steels.

The new stream degassing unit recently installed at the Standard Steel Works Div., Baldwin-Lima-Hamilton Corp. is big enough to degas a 15 ton ingot made in a single pour. The equipment was designed and installed by F. J. Stokes Corp.

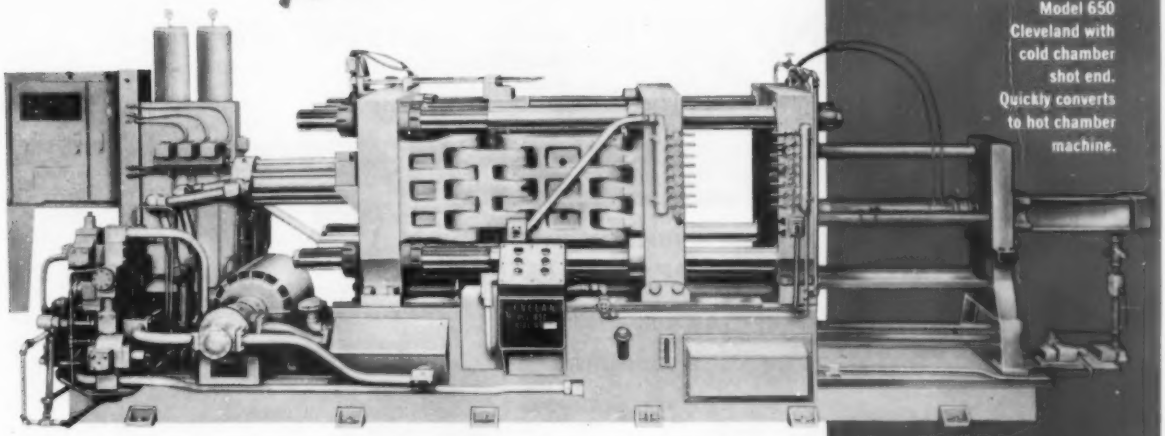


ZINC CONSUMPTION continues its steady growth. In spite of the occasional year when a downward trend seemed to set in there has been a steady increase in the use of zinc. While the overall consumption during the past 30 years has increased from about 600,000 tons to almost 1,200,000 tons per year, the most phenomenal growth has been in the casting (almost all die casting) industry. Here from less than 5,000 tons in 1925 the consumption has skyrocketed to over 400,000 tons and is continuing to grow.

According to the American Zinc Institute, the prospects for 1959 are excellent, particularly if the automotive industry hits its goal of 5.5 million units in the present model year.

Take a close look...

FOR ALUMINUM OR ZINC DIE CASTING



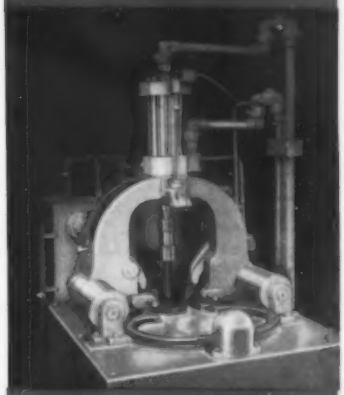
Model 650 Cleveland with cold chamber shot end. Quickly converts to hot chamber machine.

at the model 650 CLEVELAND

Cleveland's Model 650 brings to die casters a major advancement in die casting machine design. Its dozens of highly important features — many are exclusively Cleveland's — insure exceptional performance in delivering castings of precision quality at a fast production rate.

The "650" is *massive*—with guaranteed 650-tons locking pressure (strain gage tested). Maximum weight of shot is 10.6 lbs. aluminum and 25.8 lbs. zinc. It has 46½" x 46" die plates; 28" x 28" space between the tie bars; 30" max. to 10" min. die thickness; 8" to 15" die opening.

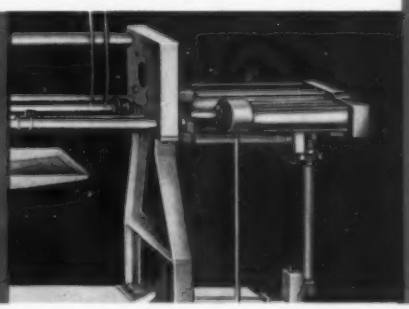
Only a few "650" features are illustrated here, but these are typical of Cleveland's all-over quality construction. For full details, call in a Cleveland sales engineer and write for descriptive bulletin.



New hot chamber shot end. Improved cast steel shot cylinder and gooseneck supports permit quick gooseneck removal. High pressure swivel joints in hydraulic lines.

Plus: Automatic timing controls seperate from machine, with push buttons convenient for operator's control . . . heavy, one-piece, machine-length base . . . extra rugged platens and toggles . . . dual accumulator system . . . manifold hydraulics . . . automatic lubrication . . . many other important construction features.

30 hp. totally enclosed motor drives two Vickers pumps which deliver 99.7 gal. per min. The 200 gal. hydraulic reservoir has filter capacity twice the pump capacity.



New shot intensifier. Will provide plunger speeds up to 480 ft./min. and pressures up to 26,070 lbs./sq. in. (Both are adjustable.)

REMEMBER,
Clevelands Cut Costs!

THE CLEVELAND AUTOMATIC MACHINE COMPANY

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Cincinnati 12, Ohio

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SOLUTION: *Ask the only manufacturer who makes all three!*

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(*Water-Glycol Fluids*)
Adequate for 85% of all hydraulic systems; provides maximum fire protection with good lubricity for systems running below 150°F. temperatures.

HOUGHTO-SAFE 1000 SERIES
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Available in three viscosities for systems running as hot as 150°F. and where maximum lubricity is needed for heavy bearing loads.

HOUGHTO-SAFE 5040 SERIES
(*Water-Oil Emulsion Fluids*)
Lower cost, fire-resistant fluids that are stable, afford good lubricity and provide adequate fire protection where hazards are intermittent or remote.

Selecting the *right* hydraulic fluid depends upon operating pressures and temperatures, pump and equipment design, degree of fire hazard, and other important factors. But to make sure you get a completely unbiased recommendation —call in the only manufacturer who makes all types.

Houghto-Safe fire-resistant fluids have proved themselves in industry's toughest hydraulic applications—not only as life and property-savers, but as efficient protection against excessive pump and packings wear. Houghto-Safe is also used extensively by the U. S. Navy for such critical carrier applications as deck-edge elevators and catapults.

For a completely unbiased recommendation of the best and most economical fluid for your equipment and degree of fire hazard, call in your Houghton representative. Or write E. F. Houghton & Co., 303 W. Lehigh Ave., Phila. 33, Pa.

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PMM LETTERS

the readers' forum

FINISHING BARRELS

Can you give us the address of the company who makes Almco Superspeed Precision Barrels as mentioned in your issue of January, 1959. – M. S. C.

The correct address is: Almco, Queen Products Div., King-Seeley Corp., Albert Lea, Minn. – ed.

SHELL MOLD CASTINGS

I wonder if you could send me a list of shell molding foundries who specialize in high strength materials, particularly steel. In the article on page 46, mention is made of Precision Mfg. Co., but I could not find their address.

Also in the January issue there is mention of low cost miniature castings made by Casting Engineers, Inc. I did find their address in your publication. We are principally interested in lists of companies doing both shell mold and investment casting – N. W., mgr.

The address of Precision Mfg. Co. is Plano, Texas. The addresses of other shell mold foundries in the more immediate vicinity have been sent. The June issue of PMM will carry a directory of the investment casters in this country. We do not publish a directory of shell mold casters. – ed.

SHAW PROCESS CASTINGS

In your Summary of Technical Literature, you described a new investment casting process being used by the Shaw Process Development Corp. Can you supply us with the address of this company. We would like to contact them, but no address was given. – L. C. C.

The correct address is: Shaw Process Development Corp., 80 Shore Rd., Port Washington, Long Island, New York. – ed.

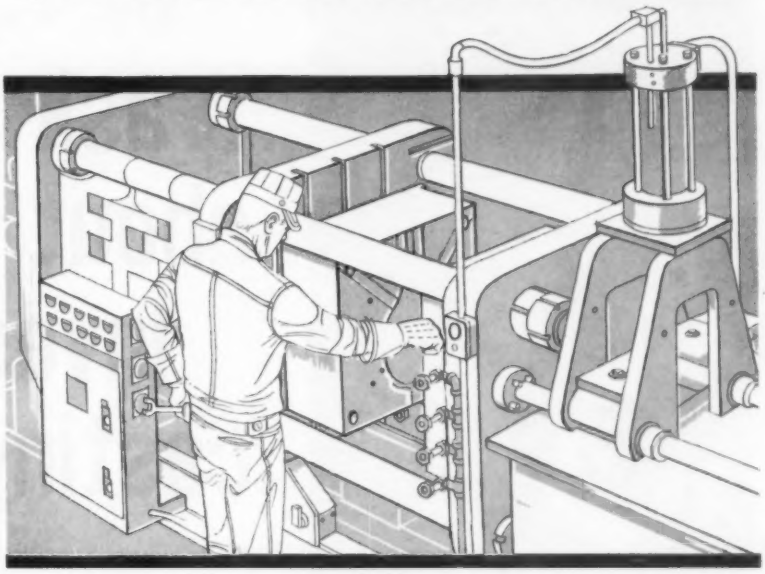
CAST ROTORS

We are considering pressure casting with aluminum, rotors for electric motors 3¾" through 5½" in diameter.

Could you please furnish us with a listing of manufacturers of such equipment. E. J. G., purchasing agent.

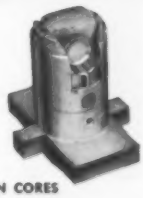
The names of companies who make machines for casting rotors have been furnished. – ed.

If you can do it with light alloys . . . you can do it BETTER with PMD dies!



DIE CASTING DIES

PERMANENT MOLD DIES



PISTON CORES

Special Equipment

- Permanent Mold Operating Devices
- D.C. Casting Units
- Billet Molds
- Coilers for Tubing
- Trim Dies

COMPLETE DESIGN AND ENGINEERING SERVICE AVAILABLE

Yes, if you produce light alloy castings, you can do it better with PMD dies! Longer service life, minimum starting problems, lower overall tooling costs — these are plus advantages you get from PMD!

One of America's largest independent producers of dies, molds, special machines and molding devices, Permanent Mold Die Company offers every facility to do the job right! Complete design-engineering service . . . skilled, experienced personnel . . . plus the specialized tools and equipment to meet every requirement.

PMD dies and molds are designed to perform to your specification! For the right solution to your tooling problems — call in a PMD specialist. Write or phone today!

PERMANENT MOLD DIE COMPANY, INC.

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Phone: SLocum 7-8100

PMD

For more information circle No. 77 on the Reader Service Card

Is your new design complex?

...ask Arwood about investment casting

When you can't simplify the part any more without sacrificing function...

When the production people tell you it will be too costly to machine...

When you think you could cut production costs by making several parts as a single piece...

When function calls for a tricky shape but the intended service makes you specify, a hard, strong, tough-to-work alloy...

When any or all of these design problems are keeping you awake nights... then is the time to consider making the part an Arwood precision investment casting.

Here's why...

Investment casting by Arwood lets you stop worrying about *how to make* the part. You can design for function and end use... Arwood will give you the shape you need, in the quantities you need, from a few hundred to many thousands. Arwood casts all the ferrous and non-ferrous metals and alloys, from aluminum and magnesium right through to stainless steel and cobalt- and nickel-base superalloys.

Write today for your free copy of the new 44-page Arwood "Practical Guide to Investment Casting". It provides all the information you need to evaluate the technique and use it to help solve your design problems.

MACHINE THE SIMPLE...CAST THE COMPLEX

arwood

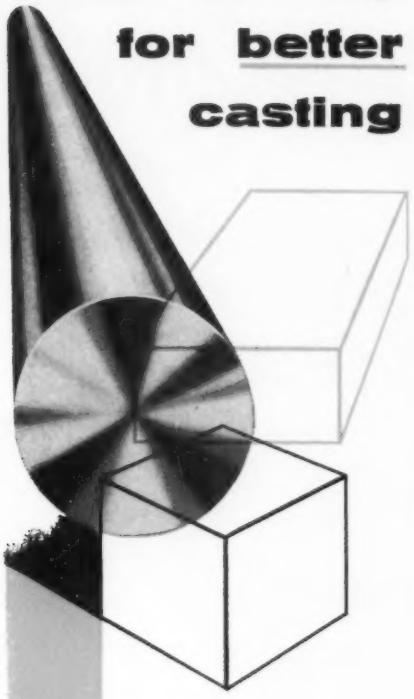
ARWOOD PRECISION CASTING CORP., 323 W. 44th St., New York 36, N. Y.

A complete service from design through tooling, production and finish machining. Sixty-two engineering consultants from coast to coast.

PLANTS IN BROOKLYN, N. Y.; TILTON, N. H.; GROTON, CONN. & LOS ANGELES, CALIF.

For more information circle No. 10 on the Reader Service Card

Produced by LATROBE Metalmasters for better die casting dies...



VDC

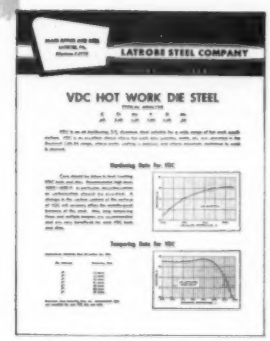
HOT WORK STEEL

Air hardening, high vanadium, Type H-13

Regardless of how intricate your zinc, aluminum or magnesium die casting job may be, Latrobe's VDC can fill your need for faster die production, longer runs and more economical parts production.

Easy to machine, VDC has a sound internal structure and freedom from porosity. It responds uniformly to heat treatment, can be water-cooled in service and possesses excellent resistance to impact, wash and heat checking.

For your next die casting die, use the die steel made by Metalmasters who *know* your requirements . . . VDC! A wide range of stocks is available from district warehouses located near you.


LATROBE STEEL COMPANY

VDC HOT WORK DIE STEEL

Send for VDC Data Sheet today!

LATROBE STEEL COMPANY

MAIN OFFICE and PLANT: **LATROBE, PENNSYLVANIA**

BRANCH OFFICES and WAREHOUSES:

BOSTON • BUFFALO • CHICAGO • CLEVELAND • DAYTON
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MIAMI • NEW YORK • PHILADELPHIA • PITTSBURGH
SAN LEANDRO • TOLEDO

For more information circle No. 56 on the Reader Service Card

when it's for precision die-casting...

specify TADANAC zinc

Zinc offers more desirable mechanical qualities and casting characteristics at a lower cost than any other metal. For the very best in die-casting zincs, specify TADANAC BRAND — or alloys made from it.

For information and assistance regarding zinc die-casting, contact our Technical Service Staff. Your inquiries will be given immediate attention.

With TADANAC BRAND Zinc you get electrolytically refined zinc of consistent high quality, low in impurities and always in good supply with prompt delivery assured.

THE CONSOLIDATED MINING AND SMELTING COMPANY OF CANADA LIMITED

COMINCO

Metal Sales Division: 215 St. James Street W., Montreal 1, Quebec, Canada

Sold in United States by: **AMERICAN METAL CLIMAX, INC.,** New York, Chicago, Detroit, Los Angeles

TADANAC ZINC SHAPES THE THINGS TO COME

9101

For more information Circle No. 21 on the Reader Service Card

U. S. ELECTRICAL MOTORS INC. DISCOVERED THAT CELANESE CELLULUBE HYDRAULIC FLUID GAVE THEM MORE THAN FIRE RESISTANCE!

Cellulube 300 also solved problems of sticking valves and line leaks... improved overall system efficiency

With ordinary hydraulic fluid, the high operating temperatures of the centrifugal caster at U. S. Electrical Motors Inc. made it essential to add detergent regularly to clean sticking valves. Furthermore, it was necessary to change hydraulic fluid frequently in order to reduce formation of sludge and varnish.

Since converting to Celanese Cellulube 300 in early '57 (primarily to eliminate the hazards of fire due to possible line breaks) it hasn't been necessary to change fluid, nor have sticking valves been a problem. In addition, valve leaks are virtually eliminated.

Celanese Cellulubes . . . the fire resistant hydraulic fluids . . . can minimize the hazard of fire in your plant and improve operating performance. They are available in six controlled viscosities (90, 150, 220, 300, 550 and 1000 S.U.S. at 100°F.) One of these is best suited to your operation. Check with your Celanese representative for full information, or write directly for evaluation sample, stating application involved. Celanese® Cellulube®

Celanese Corporation of America, Chemical Division, Dept. 589-D 180 Madison Ave., N. Y. 16.
Canadian Affiliate: Canadian Chemical Company Limited, Montreal, Toronto, Vancouver.
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22 on the Reader Service Card

Celanese
CHEMICALS

TO GET MORE OUT OF THE SHOW... **Attend the Design Engineering Conference**

Sponsored by the Machine Design Division, American Society of Mechanical Engineers

Hear major design and development problems examined by leading experts. Participate in sessions aimed to give answers to specific questions, to help you profit from the ideas and solutions of others.

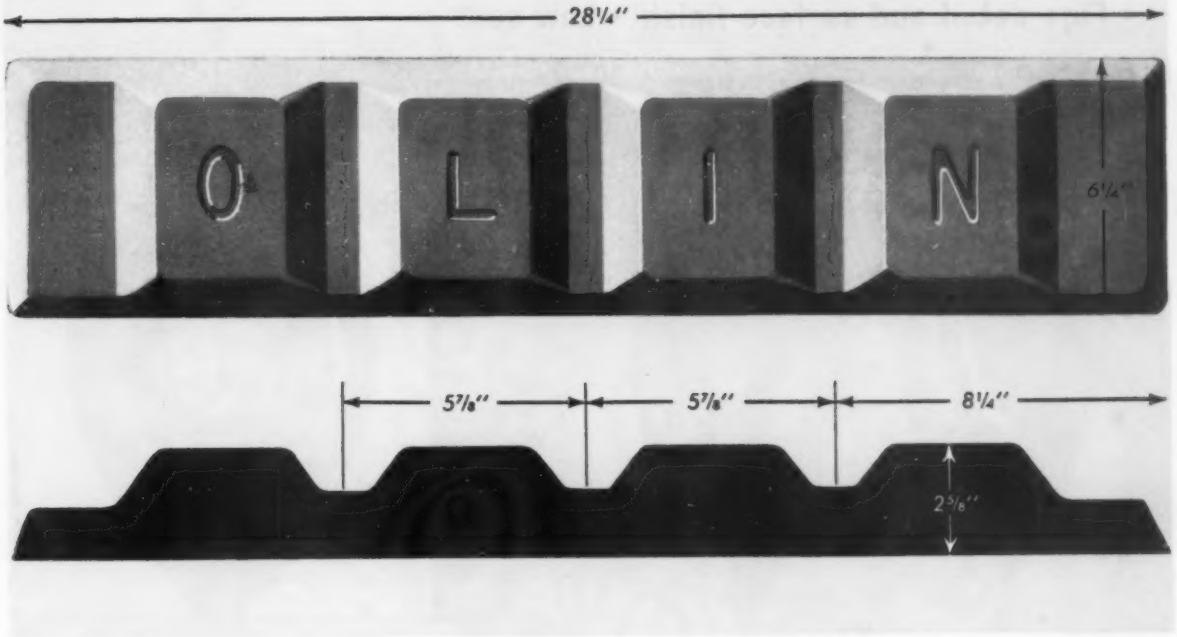
Don't miss the *must* program of the year for everyone connected with product design, research and development.

The idea show for everyone concerned with product design, research and development.

375 of the nation's leading manufacturers showing mechanical, electrical and electronic components, metals, non-metallic materials, fasteners, finishes and coatings, shapes and forms, hydraulic and pneumatic components, power transmission, research and testing equipment, engineering equipment and services. Thousands of products to help you do a better design job and reduce manufacturing costs.

Write for your Rapid Registration Cards today! Send for as many cards for yourself and your colleagues as you wish.
Write: CLAPP & POLIAK, Inc. · Exposition Management · 341 Madison Avenue, New York 17, N. Y.

YOU'LL FIND GOLD
IN THIS NEW 25 POUND OLIN ALUMINUM INGOT!



Now, a 25 pound ingot from Olin Aluminum. Consider its advantages for you!

Smaller size. Easier to store, easier to gauge metal supply for closer control.

Lighter weight. 25 lbs. vs. 30 lbs. Greatly increases handling efficiency.

Deeper notches. Easier to break. Saves time, eases work load.

More sections. 3 notches, 4 sections vs. 2 notches, 3 sections. Reduces waste.

Same price per pound as 30 lb. ingot. Olin Aluminum is the only prime supplier producing a 25 pound ingot, and at no additional cost.

America's new major aluminum producer, Olin Aluminum, is also the newest source of profitable ideas for foundrymen. Take advantage of it. Contact your nearby Olin Aluminum Sales Office or Authorized Distributor of casting alloys. Ask for our pig and ingot technical data bulletin. Metals Division—Olin Mathieson Chemical Corporation, 400 Park Avenue, New York 22, New York.

OLIN ALUMINUM

Symbol of New Standards of Quality and Service in the Aluminum Industry

For more information circle No. 73 on the Reader Service Card

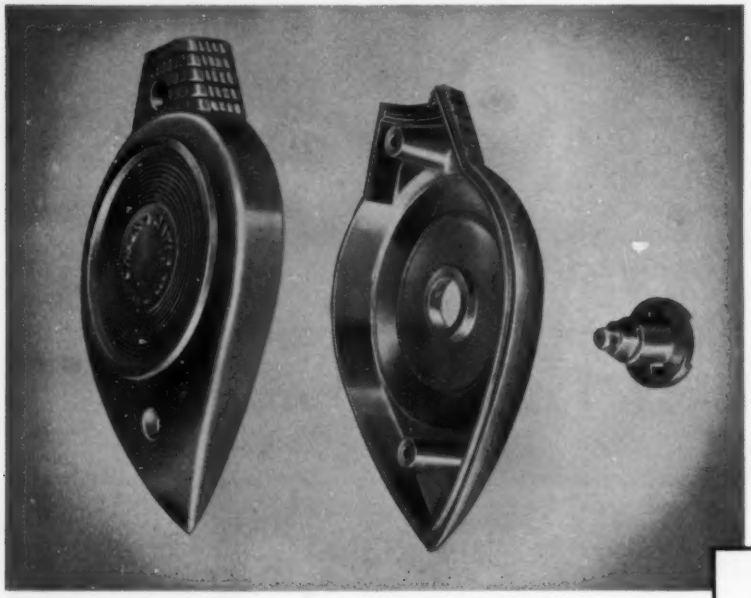
DOLLIN ALUMINUM DIE-CASTINGS

IN STANLEY'S NEW "CHALK-O-MATIC"

meet critical specs for

• Precision fit • Perfect balance and Symmetry

• Fine detail and surface finish • Low cost



"Chalk-O-Matic", made by Stanley Tools, is an ingenious self-chalking chalk line reel and a plumb bob in one compact tool. The line is automatically chalk-coated when pulled from case—then rewound with a folding crank handle. Lock the handle, the "Chalk-O-Matic" becomes a plumb bob. To prevent chalk leakage, the die-cast aluminum case sections require a precision fit. To assure a perfectly balanced plumb bob demands utmost symmetry of both case sections.

Dollin is meeting these strict requirements and supplying clean, smooth, sharply defined castings for subsequent gun-metal gray finishing. The center hubs for crank and reel are also die-cast by Dollin.

Possibly you have a new design or a re-design on the boards, that could be made smaller—lighter—stronger—more attractive—more economically, with Dollin Aluminum and Zinc Die-Castings.

Now is the time to find out. Call in a Dollin engineer for discussion—or send drawings and details for study—without obligation.

Dollin places at your service over 25 years of progressive experience in modern die-making, die-casting and machining facilities to produce your parts — from large sizes down to fractions of an ounce. These facilities are described and illustrated in a helpful 16-page brochure. Write for it today.

DOLLIN CORPORATION 25th ANNIVERSARY 1934-1959 Die-Castings

Submit prints or samples of parts for engineering advice and quotation, without obligation

Dollin Corporation, 614 So. 21st St., Irvington 11, N. J.

Sales Offices: Boston • Buffalo • Canton • Chicago • Detroit Greensboro • Louisville • Memphis • Philadelphia • St. Paul

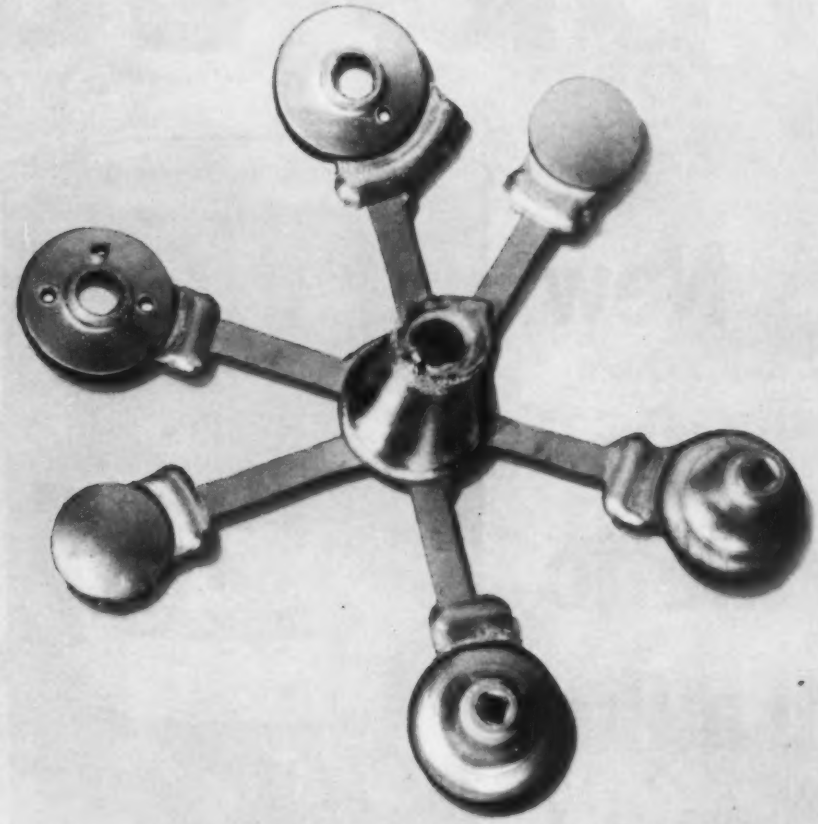
See "Yellow Pages" for nearest office.

DOLLIN Zinc & Aluminum DIE-CASTINGS

For more information circle No. 29 on the Reader Service Card

Your surest start for fine die casting: Federated-Asarco Di-Metal is made from special high grade zinc, electrolytically refined by Asarco-developed processes. Production is now concentrated "under one roof" at Corpus Christi, Texas, one of the world's largest high grade zinc producing plants. Integrated production—controlled from mine to finished alloy—assures you of lower cost materials, and the highest purity and uniformity of zinc Di-Metal. Federated can serve your needs through 22 sales offices. There's one near you. Federated Metals Division, 120 Broadway, New York 5. In Canada: Federated Metals Canada, Ltd.—Toronto and Montreal.

FEDERATED METALS DIVISION OF



ASARCO

AMERICAN SMELTING AND REFINING COMPANY

ANNOUN

(FIRESAFE)

PYDRAUL

Pydraul: Monsanto T. M., Reg. U. S. Pat. Off.

New low-cost all-synthetic hydraulic fluid

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CING

A-200

New Pydraul A-200 is the most fire-resistant synthetic hydraulic fluid you can use! It protects expensive hydraulic equipment with "built-in" antirust, even when there's water in the system! It is stable—can be used year after year with no loss of lubricating properties or firesafety!

You can add A-200 as "make-up" to your present all-synthetic fluid system. If you are using petroleum or water-based fluids, a few simple conversions set you up to run on Pydraul A-200. And you no longer need compromise on water-based hydraulic fluids because of price. Pydraul A-200 gives you all the performance of premium oils PLUS firesafety PLUS lower cost!

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Please send me ( ) copies of the Pydraul A-200 booklet.

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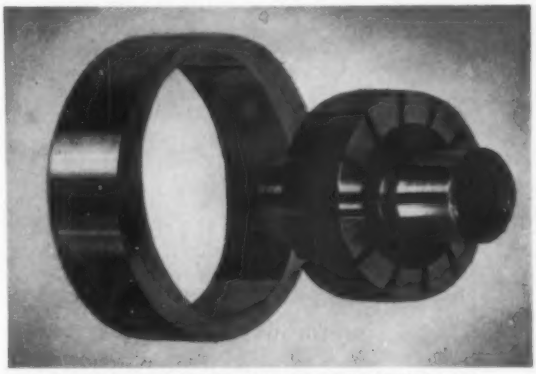
MAXIMUM FIRE PROTECTION

Pydraul A-200 won't flash or ignite—even when sprayed through the flame of an oxyacetylene torch.* Chemically "built-in" fire-resistance safeguards equipment, plant and personnel. And unlike other less expensive fluids, Pydraul A-200 leakage creates no fire hazard—there is no water to evaporate away, leaving flammable residues on walls, floors and ceilings.

*AMS-3150B high-pressure ignition test



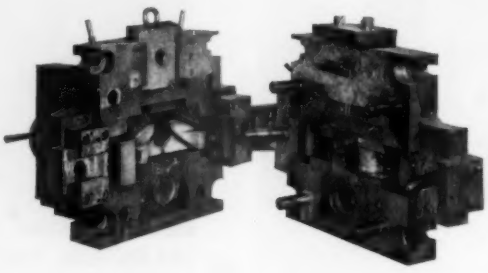
CUTS WEAR AND MAINTENANCE

Pydraul A-200 lubricates like finest petroleum oils, resists "abuse" better than other fire-resistant fluids, minimizes down time. Example: Vickers pump ring (above) shows only 0.031 g. wear after severe 1000-hour test.

STOPS CORROSION BEFORE IT STARTS

Pydraul A-200 won't rust metals, eliminates electrolytic corrosion. Perfect score on rust test (above) proves Pydraul A-200 *protects* metal surfaces, even if water gets in the system!

For more information circle No. 102 on the Reader Service Card



CROMO-HIGH V

a "long-run" grade for die-casters

Many die-casters know from experience that they can count on long production runs when they use Cromo-High V Tool Steel. And this is true whether you're casting zinc, aluminum, or magnesium.

Cromo-High V—Bethlehem's 5 pct chrome-moly tool steel with 1 pct vanadium—provides fine die-casting service because of its extra toughness, and resistance to wash and erosion. It is made by a controlled melting procedure, and has good center density and grain refinement. It is uniformly annealed for ease in machining, and is free from porosity.

Moreover, Cromo-High V is ultrasonic-tested for quality. It responds readily to heat-treatment, and permits uniform heat-treatment in massive sections to a hardness of Rockwell C45-47.

These are all good reasons for using Cromo-High V in your toughest die-casting jobs. Your Bethlehem tool steel distributor has Cromo-High V in stock, and can get it to you quickly. Call him now.

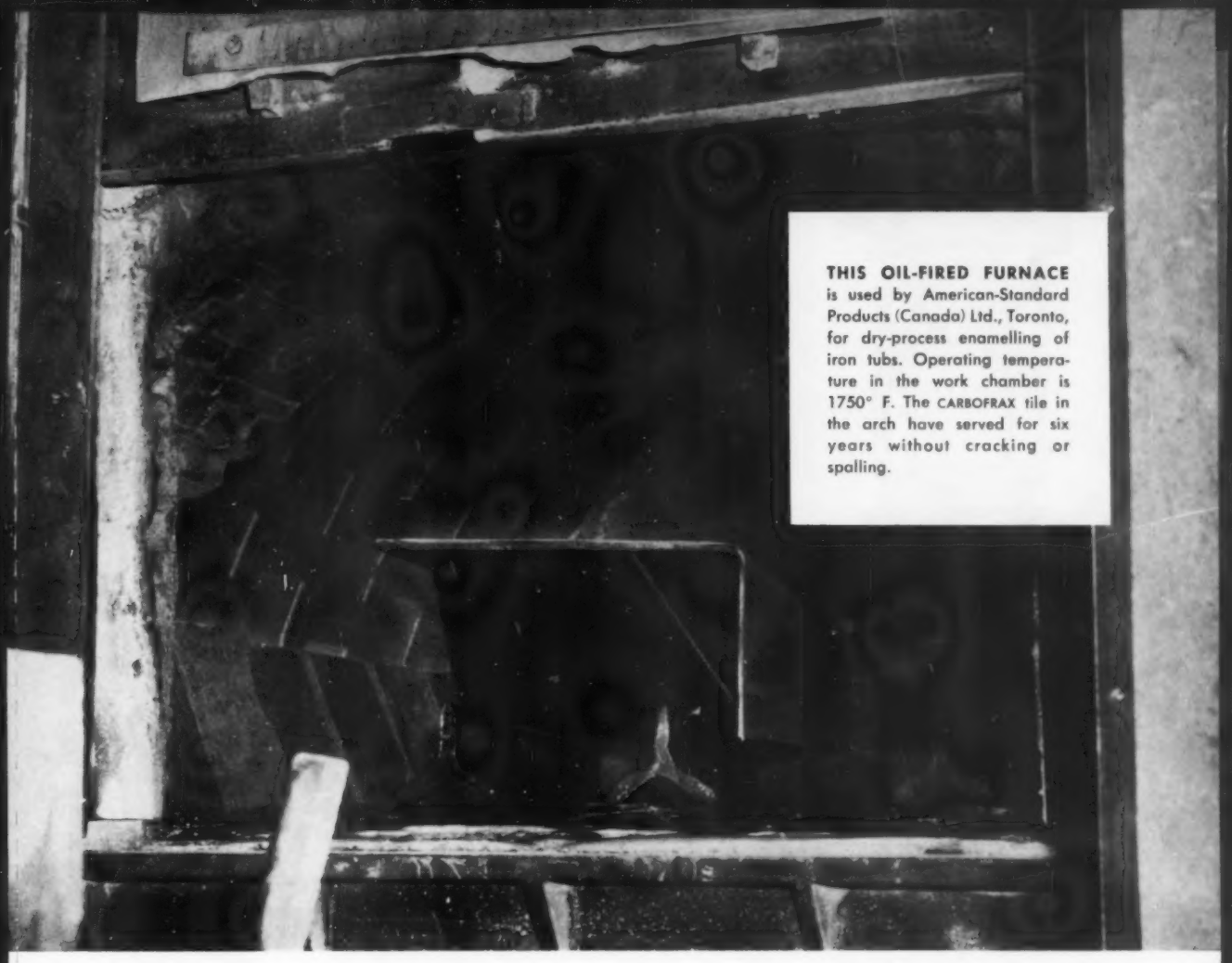
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

For more information circle No. 12 on the Reader Service Card



THIS OIL-FIRED FURNACE is used by American-Standard Products (Canada) Ltd., Toronto, for dry-process enamelling of iron tubs. Operating temperature in the work chamber is 1750° F. The CARBOFRAX tile in the arch have served for six years without cracking or spalling.

Look at the arch's tight joints

. . . then guess how old it is

Those tight joints look like a recent installation. Actually the CARBOFRAX® silicon carbide tile in the roof of this furnace have been in service *for six years*. There's no spalling, no cracking. Maintenance costs, of course, have been negligible. And the absence of cracking and spalling has reduced ware markings.

The furnace heats quickly and evenly because the CARBOFRAX tile have much more heat conductivity than fire-clay—in fact, almost as much as chrome-nickel steel.

ALFRAX® aluminum oxide tile in the floor of the furnace cut costs, too, because they resist attack by enamel drip. They give steady, rapid, heat flow to bottom of ware.

If your problem is fast, uniform heating with low maintenance, CARBOFRAX and ALFRAX tile, combined with Carborundum's engineering assistance, may be the solution. Write to Carborundum for all the facts: Dept. R-49, Refractories Division, The Carborundum Company, Perth Amboy, New Jersey.

CARBORUNDUM

Registered Trade Mark

Dept. R-49, Refractories Division, Perth Amboy, N. J.

For more information circle No. 17 on the Reader Service Card

NEW PRODUCTS AND DEVELOPMENTS

Want complete details on these announcements? Use the Reader Service Cards. You'll find them facing page 120 of this issue

HYDRAULIC TRIM PRESSES . . . *range from 25 through 1,000 tons*

The KRW line of four-column single-action hydraulic presses has been expanded to cover a range of 25 through 1,000 tons. Built by K. R. WILSON, INC., the presses are available in 48 models and are either up-acting or down-acting.

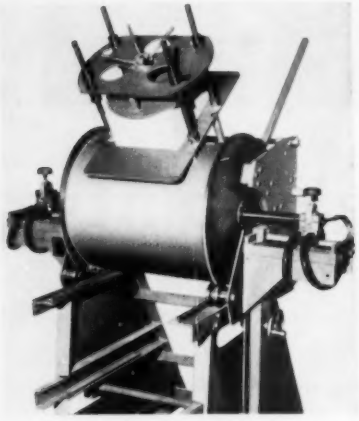
Frame construction permits access to the working area from all four sides. The crown, bed and sliding platen are designed to provide maximum resistance to deflection. The pumping unit can be mounted at the top of the press or furnished for floor installation. Manual lever or electric controls are available. Illustrated is the 20-ton four column down acting press.

Circle No. 239 on Reader Service Card

BARREL FINISHING MEDIA . . . *for stock removal*

This new triangular "Honite" brand C-R tumbling shape is said to eliminate the problems of discoloration, impingement and media fracture. It is composed of aluminum oxide mineral anchored in a 3M-developed binder. Manufactured by the MINNESOTA MINING & MFG. CO., the media is up to 2½ times faster than existing aluminum oxide chips, and as much as 12 times faster than natural stone media.

Circle No. 240 on Reader Service Card

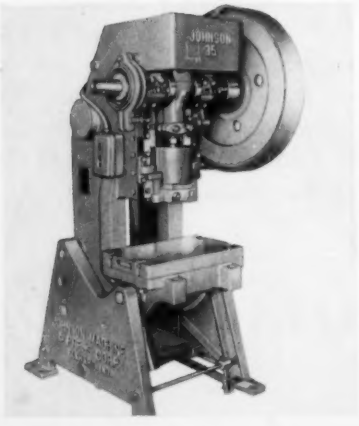


INDIRECT ARC FURNACE . . . *is barrel type*

The model 60-z Mark II, is a 60 lb. barrel type indirect arc furnace. Introduced by BRITISH MACHINE & FOUNDRY SUPPLIES, LTD., the furnace features a dump-over arrangement with a mold clamp attachment. This enables a Shaw Process or precision investment mold to be clamped directly over the pouring hole in the furnace barrel. The furnace barrel rides on ball bearing rollers and can be inverted 180° with the mold attached.

The advantages of this direct pouring method are listed as: cleaner, slag-free melts; faster and safer pouring; no pre-heating of transfer ladles; correct temperature is maintained from crucible to mold. The furnace, illustrated with the mold attached, utilizes a "Zirconal" super refractory lining that has exceptional strength and stability at high temperatures.

Circle No. 241 on Reader Service Card



OPEN BACK INCLINABLE PRESS . . . *has 35 ton capacity*

THE JOHNSON MACHINE & PRESS CORP., has introduced a new 35 ton open back inclinable press. It has a one piece, high tensile cast iron frame. The "box top" is an integral part of the main frame casting which supports the crankshaft bearings, and reduces deflection.

The model is available in conventional flywheel, or back geared styles. It comes equipped with either the Johnson pin clutch, or the Wichita air friction clutch. The main bearing caps are split on a 30 degree angle which allows the frame to absorb the shock load. Crank strokes range from the standard 2½ inches up to 6 inches.

Circle No. 242 on Reader Service Card

continued on page 110

You get speedier service from the

ZINC ZONE

Central location of American Zinc plants assures prompt deliveries of slab zinc to any point in the nation.

HILLSBORO, ILL., PLANT
Prime Western, Brass Special, Intermediate, High Grade, Continuous Galvanizing Grades
MONSANTO, ILL., ELECTROLYTIC PLANT
Special High Grade, High Grade, Continuous Galvanizing Grades, Special Shapes
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Prime Western, Brass Special
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Prime Western, Brass Special, Continuous Galvanizing Grades

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ALL GRADES OF SLAB ZINC
ZINC ANODES (Plating & Galvanic)
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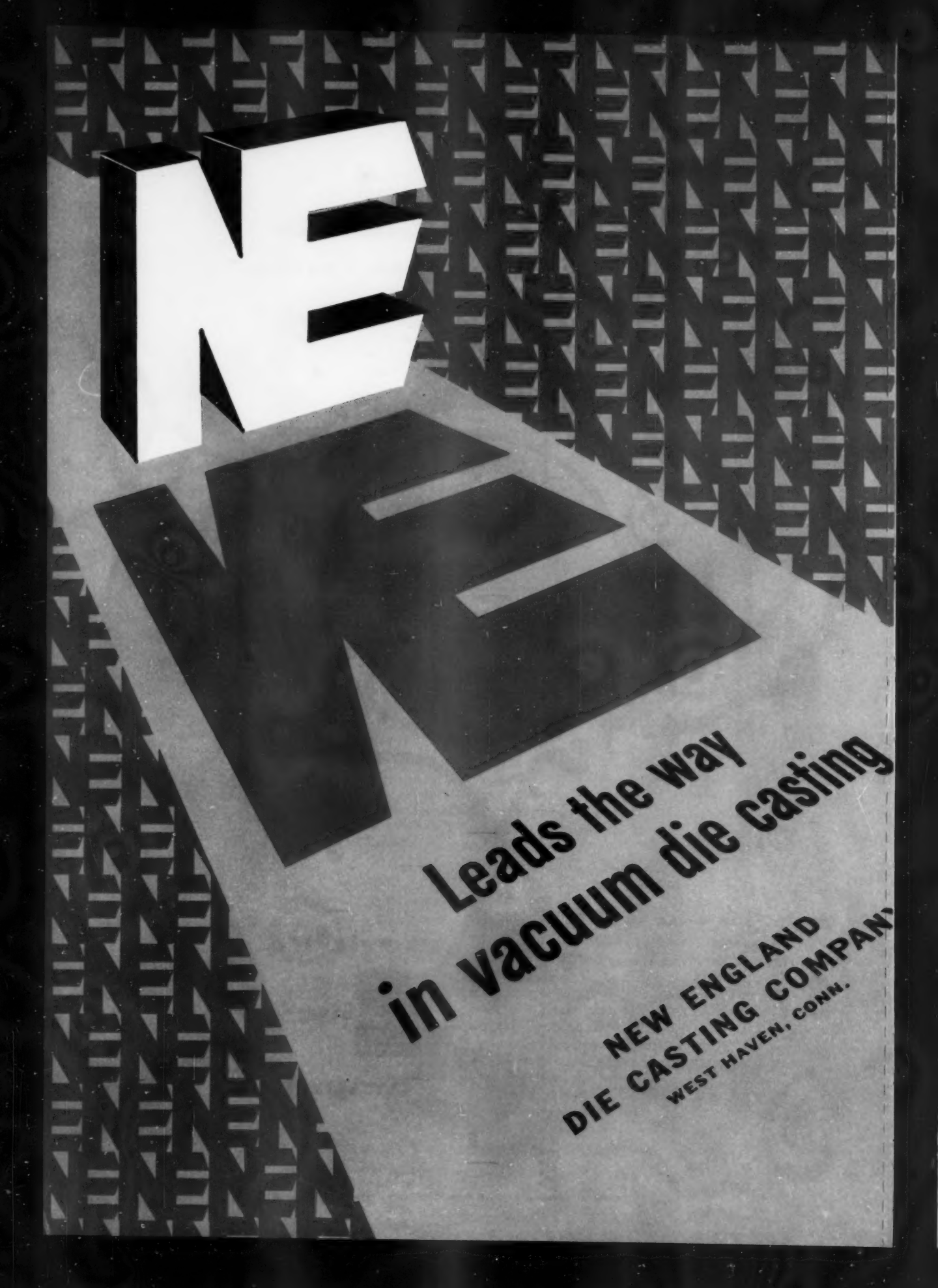
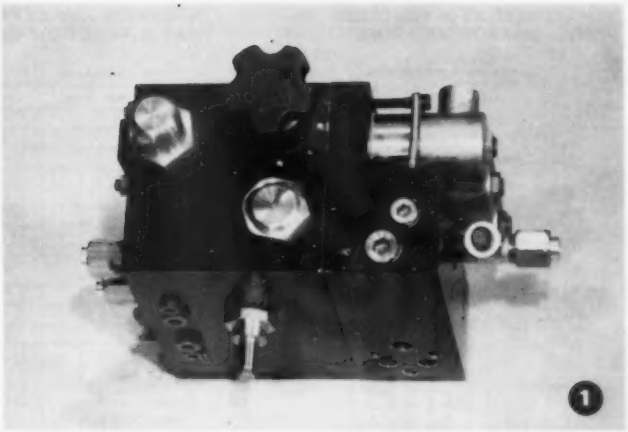
For more information circle No. 8 on the Reader Service Card


NE
Leads the way
in vacuum die casting
NEW ENGLAND
DIE CASTING COMPANY
WEST HAVEN, CONN.



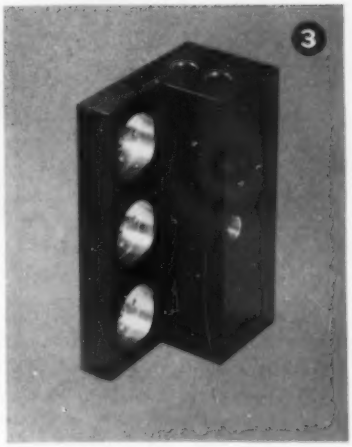
DESIGN FOR
EXTRUSIONS

FIGURE 1: Shutoff, transfer valve; body section is at left, head, right.

FIGURE 2: Extruded body section is as easily produced as simple rectangle.

FIGURE 3: Redesigning head as an extrusion has eliminated all leakage.

FIGURE 4: Parts need extensive machining; extrusions have cut rejects.



Aluminum Extrusions for Valves

by P. C. SMITH*

EXTRUSIONS tailored to a specific job can be the most economical raw material. By extruding just the right shape, whether solid or hollow, machining scrap can be reduced greatly and in most cases the remaining machine work which must be done is easier.

When compared with tooling costs for other manufacturing methods of similar precision, extrusion dies are very inexpensive. These high tooling costs and the high set-up charges in many other metal forming methods require long runs to be economical. But in extrusion, die changing is often only a matter of a few minutes, so that down time on the press is very slight. This allows the custom extruder to make short runs.

GPE Controls, Inc. has used these advantages of extruded sections in its shutoff and transfer valve shown in Figure 1.

The original design for this valve called for a body section machined from a rectangular section aluminum bar and a head made as a bronze sand casting. Neither was completely satisfactory.

*GPE CONTROLS, INC.

The most desirable shape for the body casting is shown in Figure 2. To get this shape from a rectangular shape meant fairly high scrap losses where the one surface was machined to give the contour shown. As an extrusion, this shape is as easily produced as a simple rectangle.

But the head was the most troublesome. The bronze sand castings were porous. Since these valves operate at pressures up to about 800 psi porosity could not be tolerated. The best solution was to impregnate all of the head castings. Then the head was redesigned as an aluminum extrusion shown in Figure 3. Leakage was completely eliminated.

Because of the complex functions of these valves there must be a lot of machine work done on the body and head (Figure 4).

Actual machining costs on the extruded sections are probably about the same as when the older design was used. There has been, however, a very material drop in rejects so that the overall cost of the valve has been lowered by about 30%.

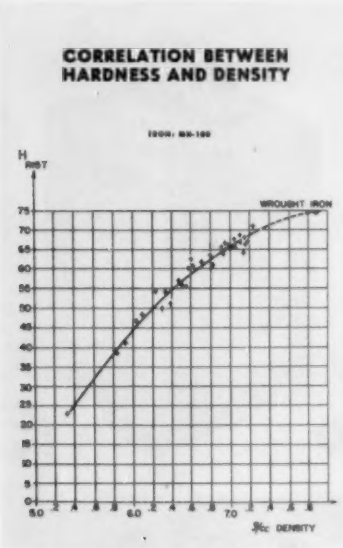
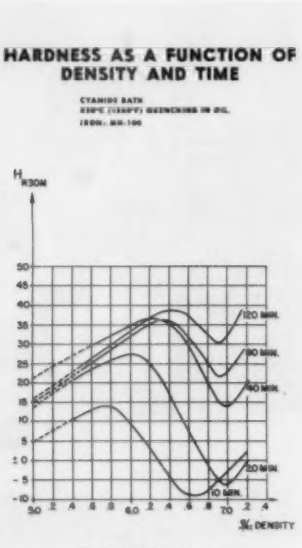


DIAGRAM No. 1



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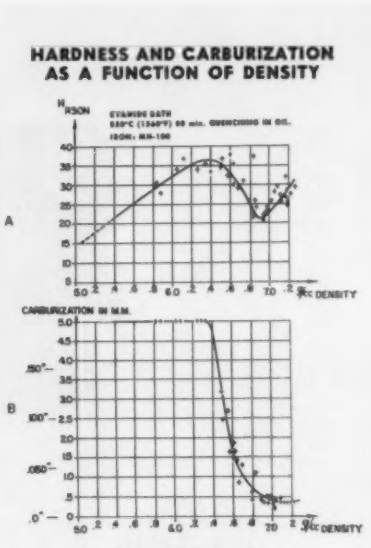

DIAGRAM No. 3

Heat Treatment of Sintered Iron

By IVAN LJUNGBERG*
and P. ULF GUMMESON**

WEAR CHARACTERISTICS of sintered parts which have been case hardened and heat treated generally are very good. However, a high sintered density and a favorable chemical composition are needed.

Often it is difficult to get reproducible hardness tests on sintered parts. This is, however, not always true. Of course, the hardness, as in ordinary solid steels, is influenced by the composition of the material, but in a sintered part the density is very important.

Some comparable tests have shown that the Brinell hardness test is the most reliable; but it is a fairly slow method. Hardness has also been measured by Rockwell 15 T (R15T). In this method the impression is made by a steel ball with 1/16" diameter. The preload is 3 kg and the second load is 12 kg. This test takes only seconds.

The results indicate that there is a continuous correlation between hardness and density as shown in Diagram 1, and it seems that in many cases hardness may be used to determine the density of a sintered part. It is of particular interest to use this method for density determinations within one part.

For testing hardness of hardened sintered parts, it is better to use the Rockwell 30 N (R30N). A diamond cone with 120° top angle is used. The load in this case is 30 kg.

The core of a sintered plain iron part will not be changed in hardness during case hardening. The surface of the part, however, will be much harder due to carburization. If such a part is hardness tested by the Rockwell C method with a load of 150 kg, the diamond cone will penetrate into the soft core and give too low hardness values. This may also be the case with R30N method if the carburized surface layer is very thin. It is also easy to understand from Diagram 1 that the hardness will increase with increasing density at constant thickness on the carburized layer.

HARDNESS TESTS

A series of tests were made with specimens of different densities and with the dimensions 10 x 20 x 25 mm. Carburizing was done for different times in a cyanide bath. The results, shown on Diagram 2, were somewhat unexpected. Hardness increases with increased time in the cyanide bath. Moreover, there is a hardness maximum somewhere between 6.0 and 6.5 g/cc density and there is a hardness minimum around 6.9 g/cc density. After that the hardness increases with increasing density. To explain this it must be remembered that the hardness is dependent on the carburization depth which is dependent on the density.

Diagram 3 shows hardness and carburization as a function of density after 80 minutes case hardening at 850° C. The test pieces were completely carburized throughout at densities between 5.40-6.40 g/cc. The hardness at these densities increases in a straight line with increasing density. The rapid change in hardness from the maximum at 6.4 g/cc density to the minimum at 6.9 g/cc density is obviously due to the rapid change in carburization depth at these densities. Above the 6.9 g/cc the carburization is constant and thus a regular increase in hardness takes place.

These differences are leveled off at heavier carburization or longer

This report is based on findings at the Husquarna Vapenfabriks A/B and we are indebted to them and their U. S. representatives, A. Johnson & Company, Inc. for placing the material at our disposal.

*MANAGER, POWDER METALLURGICAL DEPT., HUSQUARNA VAPENFABRIKS AKTIEBOLAG
**PRESIDENT, HOEGANAES SPONGE IRON CORP.

CARBURIZATION AND HARDNESS CYANIDE HARDENING 850°C (1560°F)

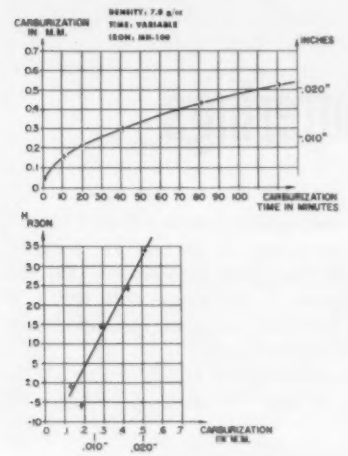

DIAGRAM No. 4

CARBURIZATION AS A FUNCTION OF DENSITY AND SURFACE CONDITION

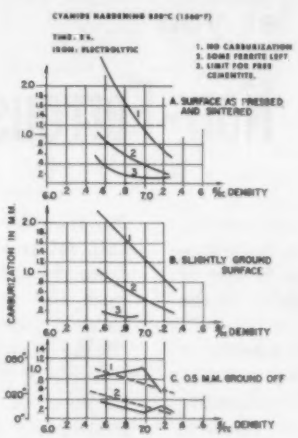

DIAGRAM No. 5

HARDNESS AND CARBURIZATION AS A FUNCTION OF DENSITY

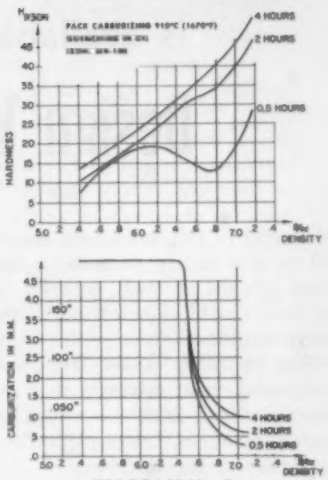

DIAGRAM No. 6

HARDNESS AS A FUNCTION OF DEPTH OF CARBURIZATION BY USE OF DIFFERENT CARBURIZERS

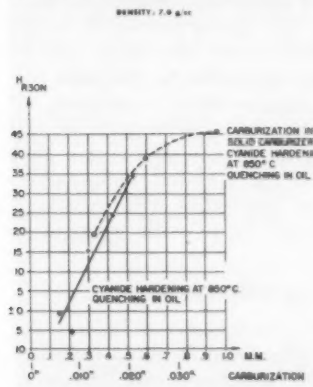

DIAGRAM No. 7

TABLE I

EFFECT OF COPPER ON STRENGTH OF ELECTROLYTIC IRON POWDER

Group	Material	Density g/cm³	Carburization mm	Hardness RC	Hardness R30N	Impact strength kg/mm²	Transverse rupture strength kg/mm²
1	Unalloyed	7.0	0.27	-	45	440	63
	"	7.0	0.35	-	48	416	65
	"	7.0	0.70	15	55	395	84
2	Unalloyed	7.48	0.35	-	43	632	93
	"	7.48	0.50	0	54	563	97
	"	7.48	0.80	22	59	465	110
3	2% Cu	7.28	0.40	18	65	427	81
	"	7.28	0.60	33	70	380	87
	"	7.28	0.90	45	70	350	97

times as can be seen in Diagram 2.

The curves in Diagram 4 are self-explanatory and show similarity to those of unalloyed rolled steel that has been case hardened.

INFLUENCE OF DENSITY ON THE SURFACE LAYER

It could be assumed that there should be an almost linear correlation between density and carburization if conditions were favorable. Metallographic examination shows, however, that the density of the surface layer is of utmost importance. Thus it was noted in one case that the carburization of the two surfaces meeting the punches were lower than on other surfaces. To study this problem more closely, a separate investigation was made where carburization was measured after the test pieces had been given different surface treatments before case hardening.

The results of this investigation are shown in Diagram 5. Curves No. 1 show the distance from the surface where no carburization has taken place and Curves No. 2, the distance from the surface where there is still some ferrite left. Finally, Curves No. 3 show how far below the surface free cemetite could be found. The trend in this diagram is that the carburization decreases with more grinding of the surface. Unfortunately, there is much left to be investigated and explained on this subject.

PACK CARBURIZATION

Some investigations were made with pack carburizing at 910°C (1670°F). The test pieces were packed in steel containers together with solid carburizers. The time for carburizing was counted from the moment the boxes had reached the furnace temperature which took about 20 minutes. Cooling was made in the boxes, after which the test pieces were heated to 850°C (1560°F) in a cyanide bath and then quenched in oil. The results are shown on Diagram 6. The curves are similar to those for cyanide hardening, but the deeper carburization in these tests has caused the hardness minima to be less noticeable.

In Diagram 7 hardness is shown as a function of carburization depth at 7.0 g/cc and this curve is valid

continued on page 58

A wide variety of metal powders is available to let you . . .

Design With Non-Ferrous Sinterings

IN SPITE of the limitations imposed by rigid tooling and by the variety of motions that can be built into either presses or tools, powder metallurgy is one of the most flexible fabricating methods available to the design engineer.

This flexibility comes from the infinite variety of metal alloys and mixtures that can be used to fabricate parts and from the wide latitude in processing to give special or different physical and/or mechanical properties to the sinterings.

The value of this versatility is possibly more pronounced in the non-ferrous metals field than in the ferrous metals field. In the case of iron powders, the designer is generally interested in using a sintering to replace, or in place of, an iron casting or a part machined from wrought metal. In this case he determines the *real* properties which the part must have and then, within the physical and mechanical limitations of a ferrous sintering, designs his part. The chief concern becomes one of economics. If a sintering is less costly, then powder metallurgy has a new customer.

With non-ferrous powder metallurgy, however, the same approach is an over simplification. Some parts, notably pure copper sinterings for such applications as commutator segments, collector rings, etc. are simple replacements based on cost only. Some brass compacts fall into this same class though both brass and nickel silver sinterings are used far less than they could be due mostly to lack of knowledge at design level. For example, comparative properties of annealed 80-20 wrought brass compared with the same alloy as a sintering are:

	Ultimate Tensile Str. psi	Hardness R_B	Elongation % in 2"
Wrought 80-20 brass (annealed)	43,000	11	50
Sintered 80-20 brass	35,000	6	25

(Note: the sintered bar had a density about 93% of theoretical). The differences are not great and, while no figures are available, it is probable that the yield in tension would compare with wrought brass quite as favorably. In the case of nickel silver a similar comparison can be made, though the sintered metal does not, usually, compare with wrought material as favorably.

It is somewhat dangerous to apply test bar results on mechanical properties to design since the actual properties secured in the sintering will vary largely due to the shape of the part. However, some general design figures are available that represent the minimum properties to be expected. These mechanical properties, Table I, can be used with considerable safety in design. Note that yield in tension is not given. No reliable figures have been developed and where this information is necessary it should be secured from the fabricator of the parts. Remember that the best and most economical sinterings will result if there is consultation between designer and fabricator during design of the sintered part.

Some of the non-ferrous metals which are available as powders and are, or may become, of commercial importance are:

ALUMINUM

ALUMINUM — High purity aluminum with, in some cases, controlled oxide content is available in a wide variety of particle sizes. This powder has been used in Europe and is gaining use in this country for making preforms which are later press formed or forged to final shape. Parts made from aluminum powder show superior mechanical properties to the same part cast or formed from non-powdered aluminum. At present it is believed that the aluminum oxide acts as the strengthening agent. These aluminum parts are particularly attractive at elevated temperatures where the degradation of properties with increasing temperature is much slower than with wrought or cast aluminum.

BRASSES & BRONZES

BRASSES & BRONZES — A wide variety of brasses and bronzes are available in powdered form. As indicated above, these powders can be pressed and sintered to almost full density. They have physical and mechanical properties that closely approach those of wrought material of the same composition and in many cases are superior to cast brass or bronze. All of them can be made with controlled porosity when desired.

BERYLLIUM

BERYLLIUM — Until recently beryllium metal has had no important commercial uses. A few uses have developed in the nuclear energy field. Recently, however, beryllium has shown some promising applications, especially at elevated temperatures, where its favorable strength/weight ratio makes it attractive to aircraft and missile manufacture. Powder metallurgy is still the most favorable method of fabricating this metal.

Beryllium-copper and beryllium-nickel alloys are both available in the powder form. Sinterings made from these alloys are used where high strength, corrosion resistance and high electrical conductivity are required.

COBALT

COBALT — Powdered cobalt is finding uses in the manufacture, by powder metallurgy, of high temperature-

high strength alloy parts. Some cobalt is also used in the manufacture of metal-glass seals since coefficient of expansion can be controlled more easily by working with powders than by normal melting practices. Cobalt is also widely used in the manufacture of permanent magnets by powder metallurgical methods.

LEAD

LEAD — Lead powder is used mostly as an additive to copper, brass and bronze alloy powders. High lead contents can be secured through powder metallurgical methods that are impossible by melting, casting and fabricating.

MOLYBDENUM

MOLYBDENUM — Until recently, the only method of fabricating this metal was by powder metallurgical methods. They are still the most widely used. Molybdenum alone or in combination with other metals and non-metals has extremely interesting high temperature-high strength properties. It will probably become increasingly important in the near future.

COLUMBIUM

COLUMBIUM — One of the newer commercial metals, columbium has interesting high temperature-high strength properties. It is of some interest in nuclear energy work and for high altitude, high speed missiles.

TANTALUM

TANTALUM — Powder metallurgy is still one of the best methods for fabricating this metal. Its remarkable resistance to oxidation and corrosion and its electrical properties make it important. Some of the carbides of tantalum are widely used for cutting tools and for die segments.

TITANIUM

TITANIUM — The advantageous properties of titanium have been well publicized over the past several years. While techniques for the melting and casting of titanium are well known, there are many parts which still require powder metallurgy as a fabricating method. One of the more outstanding applications in recent years is the titanium filter widely used in aircraft. Titanium carbide is an important component of some cutting tool compositions. Titanium copper and titanium nickel alloys in the powder form are used for their corrosion resistance and as a means of adding titanium to other powder mixtures.

TUNGSTEN

TUNGSTEN — Tungsten, like molybdenum, is fabricated by powder metallurgical methods. Thus far, very few applications for the parts, as sintered, have developed. Generally the sintered bars are hot and cold worked. Tungsten carbide is the major component of most cemented carbide tools.

ZIRCONIUM & HAFNIUM

ZIRCONIUM & HAFNIUM — These metals either alone, or in combination are just beginning to become industrially important, mostly in nuclear energy fields. Pure zirconium is sometimes added to copper compacts to form a precipitation hardening alloy.

SOLDERS

SOLDERS — Both soft solders in various compositions and silver solders are prepared as powders. They are used in furnace joining by either pressing preforms from the powder or by making a paste with a suitable vehicle which can be painted onto the parts to be joined.

More design data in PMM next month.

TABLE I

TYPICAL PROPERTIES OF COPPER BASE SINTERINGS FOR DESIGN USE

Composition: Percentages of:									Properties				
Fe	Cu	C	Sn	Zn	Ni	Sb	Pb	P	Density grams per cc	Ultimate Tensile PSI	Elongation in percent of 2"	Rockwell Hardness	Yield in Comps.
	100								7.0-8.0	7-17,000	2.0-8.0	H-28-70	
	100								8.0-8.4	16-25,000	6.0-14.0	H-51-75	
	87.5 90.5	1.75 Max	9.5 10.5						6.2-6.6	15,000	2.5	H-50	16,500
	87.5 90.5	1.75 Max	9.5 10.5						7.0-Min	20,000	3.0	H-80	28,000
	90		10						6.4-6.8	12-16,000			
	86	1.5	10				2		6.8-7.2	18,000			
	90			10					7.2-7.8	17-25,000	9.0-17.0	H-38-72	
	80			20					7.8	30,000			
	78			20			1.5		7.5-8.0	27-34,000	10.0-18.0		
	78.5			20			1.5		6.7-8.0	13-28,000	7.0-12.0	H-34-87	
	78.5			20			1.5		7.89-8.18	28-39,000	3.0-4.0	E-69-86	
.25 Max	77 80		0.1 Max	Bal	0.1 Max	0.1 Max	1 2		7.2-7.7	21,000	12.0	H-70	12,000
.25 Max	77 80		0.1 Max	Bal	0.1 Max	0.1 Max	1 2		7.8-Min	28,000	6.0	H-89	21,000
	64			18	18				7.5-7.9	32,000	10.0	H-92	18,000

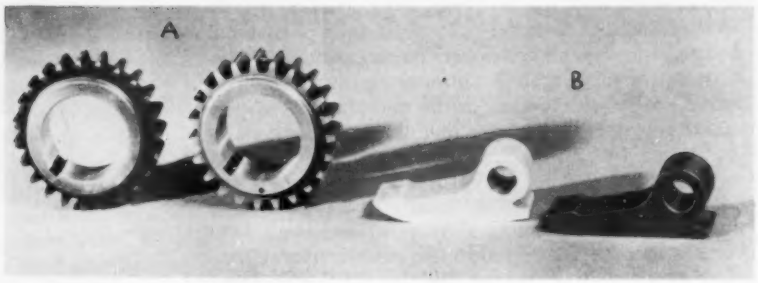

FIGURE 1. Sintered '59 transmission components include this timing chain sprocket (A, right) which replaces a conventional machined steel gear (A, left); also a transmission kickdown lever (B, right) which replaces machined extrusion (B, left). *Courtesy Chrysler Corp., Amplex Div.*

MPI Reports . . .

More Sinterings In '59 Cars

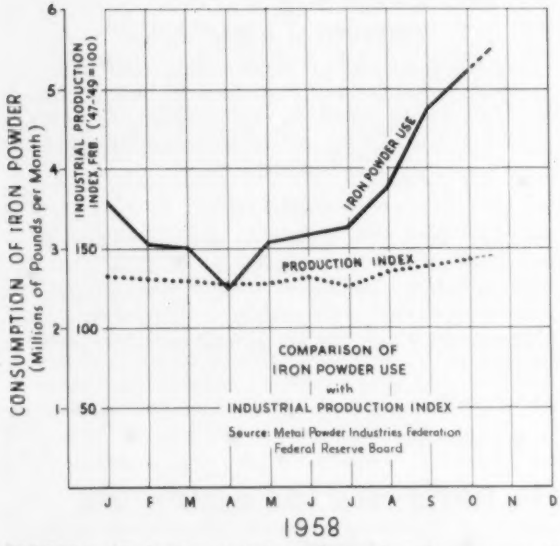

FIGURE 2. Production statistics indicate that the recovery of the iron powder industry from the recent recession has been more pronounced than the average of other basic industries.

FIGURE 3. Transmission oil pump rotor is inspected after automatic ejection from compacting press. *Courtesy Ford Motor Co.*

THERE IS a significant increase in the use of powder metallurgy parts for structural components by the automotive industry. This trend has been developing over the past ten years.

Detailed tabulations from Chrysler and General Motors (Table I) show the extent to which sinterings have penetrated into new car design. Indications from the Hardware and Accessories Division of Ford are that, perhaps, Ford uses even more powder metallurgy parts than the other two of the "Big Three". The Ford Fairlane 500 Fordor, for example, uses five pounds of powder metallurgy hardware and accessories in addition to structural and other parts not tabulated. New models of American Motors and Studebaker-Packard cars show a similar trend.

Reports from Chrysler show an average powder metallurgy structural parts usage of well over six pounds and from General Motors well over seven pounds. Both of these figures are for a "typical" car representing a composite of all price models. These figures do not include powder metallurgy components of many subassemblies which are purchased from outside sources. Some purchasing executives guessed that if an accurate count could be made of every powder metallurgy part, the total weight might conceivably be doubled.

Much of the increased use of powder metallurgy parts is in iron powder components, which are almost always specified for structural use. In the Chrysler cars for instance, three iron-base parts – the transmission kickdown lever, the transmission plug and the timing chain sprocket – have replaced extruded aluminum, machined steel and pearlitic malleable iron (Figure 1). All three of these parts take heavy shock loads and have long life requirements, since they are located in areas where individual part replacement is extremely difficult. New developments in new type of iron powder alloys, and especially the new trends in processing – such as the production of high density and infiltrated parts – are responsible for this change-over in many cases. As shown in Figure 2, this trend is reflected in greatly increased iron powder use.

TABLE I

Type of Part	Weight of Part in Pounds Chrysler	General Motors
Iron Base		
Structural parts in models with optional equipment	4.837	3.76
Structural parts in models without optional equipment	2.915	1.36
Bearing applications	0.796	1.74
Copper Base		
Total with optional equipment	0.697	0.617
Total without optional equipment	0.434	0.877
Total Sintered Metal Usage		
Including optional equipment	6.330	7.53
Without optional equipment	4.145	5.23

NEW DEVELOPMENTS

The more widespread use of powder metallurgy parts for automotive structural applications is a direct result of the successful development of new techniques for producing high strength iron powder parts, and parts with "selective" properties. Extremely high physical and mechanical properties are now available through the use of "infiltrated" or high density iron powder parts.

Infiltration of iron "skeletons" by copper or brass gives higher strength and hardness values, and uniform density particularly in non-uniform or extremely heavy sections. Ford, for instance, is taking advantage of these new techniques in the production of a copper-infiltrated sintered iron rotor (Figure 3) used in the transmission oil pump drive mechanism. By switching from alloy steel bar stock, Ford eliminated a screw machine operation and an expensive hobbing operation. Tolerances are extremely close, yet cost savings are substantial through the elimination of expensive machining and scrap loss.

Weighing 0.81 pound, the Ford oil pump rotor illustrates the trend toward larger structural powder metallurgy parts.

The new high strength powder metallurgy parts are a "natural" for highly stressed automotive components. By carburizing and hardening before use, iron powder parts with ultimate tensile strengths as high as 200,000 psi are available. A start in this direction has been made by Chevrolet in the production of a valve rocker arm ball (Figure 4) used in its 1959 V-8 engines. This part must withstand compression loads up to 45,000 psi, 1800 times per minute. Because of the advantages of controlled density – allowing lubricant to feed contacting surfaces under high pressure and speeds – the iron powder part was specified to replace a ball stamped from cold rolled and hardened steel.

For use in its single cylinder engine, Briggs and Stratton redesigned a starting mechanism cam from a five-part assembly to a single powder metallurgy part; not only were significant cost savings achieved, but the single part withstands high shock loads and shearing under high torque.

An interesting use of high strength iron powder has been made by the Midland-Ross Corporation, Owosso, Michigan, in the production of a cam for an air control valve assembly (Figure 5). Operated by hand, the assembly controls the opening and closing of bus

continued on page 106

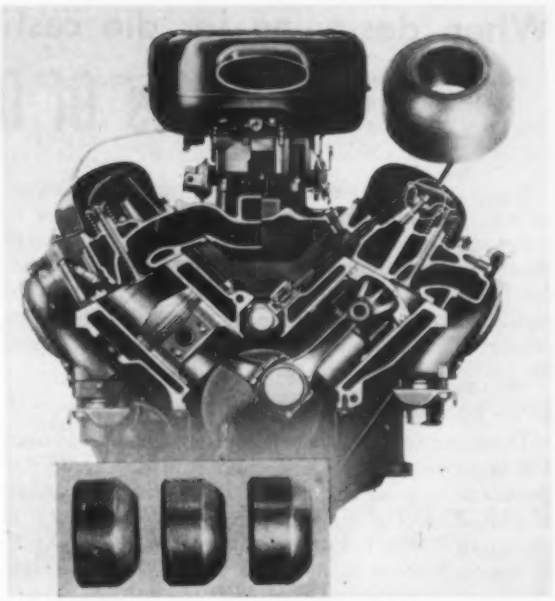

FIGURE 4. Valve rocker arm ball for Chevrolet engine is shown at bottom (left to right) as sintered, after carburizing, and after carbonitriding; hardness increases from Rockwell B 10-15 to C 10-15, then to C 20-25. *Courtesy Dixon Sintalloy Inc.*

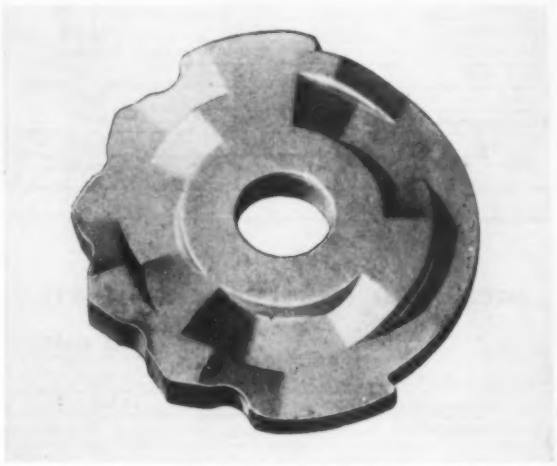

FIGURE 5. Integral face and disc cam is made to tolerance of ± 0.0025 in., carburized before use. *Courtesy Powdercraft Corp.*

FIGURE 6. Forerunner of extremely large powder metallurgy parts to be produced in newly-developed presses is this 30-inch iron-powder ring. *Courtesy Chrysler Corp., Amplex Div.*

When designing for die casting, use these . . .

Properties Of Die Casting Alloys

WHEN COMPARED WITH grey iron castings, die castings in zinc, aluminum or magnesium show up better in every department. They're as strong or stronger in tension, will take just as much impact, weigh less, can be made more complex (hence more nearly complete), frequently require no surface machining to prepare them for final finishing, and can be designed for use with high speed fastening devices.

ZINC BASE DIE CASTINGS

There are two zinc base alloys now being die cast. ASTM Alloy AC43A (XXI) and AC41A (XXV). Of these a very great majority of the castings are made in alloy XXI. The major difference in composition is shown in Table I. For most purposes alloy XXI is preferred because of its better casting qualities, but where higher impact strength is needed alloy XXV may be desired. The comparative physical and mechanical properties of the two alloys are shown in Tables II and III. The same general superiority of alloy XXI in all properties except impact has been shown in the mechanical properties at temperatures from –40° F to +203° F. At all test temperatures above 32° F the impact strength of XXV is slightly higher than that of alloy XXI, but tensile strength and hardness are lower. There is little difference in elongation.

For most design purposes, the data given in these tables is sufficient. While the results given were determined on test bars, the properties of the castings are sufficiently close to test bar results so that these data can be used safely.

ALUMINUM BASE DIE CASTINGS

There is a much wider choice of alloys available in the aluminum base group than in zinc. Initial choice may be based on Table IV which gives the most widely used classification.

The chemistry of these alloys is given in Table V. In general the physical and mechanical requirements will dictate the alloy choice. However, if the die casting is to be black anodized the lowest possible silicon content material that will do the desired job should be used.

Typical physical properties of die cast aluminum alloys are given in Table VII. There is so little differ-

TABLE I

ASTM B 86 CHEMICAL REQUIREMENTS

MATERIAL	ALLOY XXI, %	ALLOY XXV, %
Copper	2.5-3 5	0.75-1.25
Aluminum	3.5-4.5	3.5-4.3
Magnesium	0.02-0.10	0.03-0.08
Iron, max.	0.100	0.100
Lead, max.	0.007	0.007
Cadmium, max.	0 005	0.005
Tin, max.	0.005	0.005
Zinc	Remainder	Remainder

TABLE II

MECHANICAL PROPERTIES OF ASTM XXV

	AS CAST
Impact strength of 1/4- by 1/4-in. test bars	48
Tensile strength, psi	47,600
Tensile elongation, % in 2 in.	7
PHYSICAL CONSTANTS	
Brinell hardness	91
Compression strength, psi	87,000
Electrical conductivity, mhos/cm cube at 20°C	153,000
Melting point, °C	386.1
Melting point, °F	727.0
Modulus of rupture, psi	105,000
Shearing strength, psi	38,000
Solidification point, °C	380.4
Solidification point, °F	716.7
Solidification shrinkage, in./ft.	0.14
Specific gravity	6.7
Specific heat, cal/g/°C	0.10
Thermal conductivity, cal/sec/sq cm/cm)/°C at 18°C	0.26
Thermal expansion per °C	0 0000274
Thermal expansion per °F	0.0000152
Transverse deflection, in	0.16
Weight, lb/cu in	0.24

TABLE III

MECHANICAL PROPERTIES OF ASTM XXI

	AS CAST
Impact strength of 1/4- by 1/4-in. test	35
Tensile strength, psi	52,100
Tensile elongation, % in 2 in	8
PHYSICAL CONSTANTS	
Brinell hardness	100
Compression strength, psi	93.000
Electrical conductivity, mhos/cm cube at 20°C	146 000
Melting point, °C	379.5
Melting point, °F	715.1
Modulus of rupture, psi	116.000
Shearing strength, psi	46,000
Solidification point, °F	714.7
Solidification point, ° F	714.7
Solidification shrinkage, in./ft	0.15
Specific gravity	6.7
Specific heat, cal/g/°C	0.10
Thermal conductivity, cal/sec/sq cm/cm)/°C at 18°C	0.25
Thermal expansion per °C	0.0000277
Thermal expansion per °F	0 0000154
Transverse deflection, in	0.22
Weight, lb/cu in	0.24

ence in physical constants for the different materials that seldom will it be necessary to make an alloy choice based on these properties. Only in the exceptional cases where, for example, the highest possible electrical and thermal conductivity must be had will these physical properties have any effect.

In the case of mechanical properties, there is a very material difference in the different alloys. While yield strength in tension does not vary greatly, there is a difference of more than 50% in the ultimate tensile strength. Elongation varies by a factor of 9 to 1 and there is a very appreciable difference in yield in compression. These data are given in Table VI.

Finally, the elevated temperature properties are of importance, Table VIII. Certain of the alloys, notably S12B and A360, have exceptional ultimate tensile strength at temperatures as high as 500°F. These properties are becoming more important as higher and higher operating temperatures are required in some of the modern applications. Gas turbines for automobiles and trucks for example. In such applications weight is very important and the light alloys will be in demand, if they can operate at elevated temperatures.

continued on next page

TABLE IV

CLASSIFICATION OF ALUMINUM CASTING ALLOYS BY TYPE OF APPLICATION

APPLICATION	ALLOY
General purpose alloys	S12A SC54A SC84B SG100A
General purpose alloys where pressure-tightness is required	SC84B SG100A
Alloys for architectural and decorative purposes	G8A S12A SG100A
Alloys with high resistance to corrosion	G8A S5C S12A SG100A
Alloys retaining strength at elevated temperatures	SC84A SC84B SG100A
Piston alloys	SC84B

TABLE V

CHEMICAL COMPOSITION OF ALUMINUM DIE-CASTING ALLOYS

Alloy designation		Aluminum %	Copper %	Iron max, %	Silicon %	Manganese %	Magnesium %	Zinc max, %	Nickel max, %	Tin max, %	Other constituents, except aluminum max (total), %
ASTM	Commercial										
G8A	218	Remainder	0.2 max	1.8	0.3 max	0.3	7.5-8-5	0.1	0.1	0.1	0.2
S5C	43	Remainder	0.6 max	2.0	4.5-6.0	0.3	0.1 max	0.5	0.5	0.1	0.2
S12B	13	Remainder	0.6 max	2.0	11.0-13.0	0.3	0.1 max	0.5	0.5	0.1	0.2
S12A	...	Remainder	0.6 max	1.3	11.0-13.0	0.3	0.1 max	0.5	0.5	0.1	0.2
SC54B	85	Remainder	3.0-4.0	2.0	4.5-5.5	0.5	0.1 max	1.0	0.5	0.3	0.5
SC54A	...	Remainder	3.0-4.0	1.3	4.5-5.5	0.5	0.1 max	1.0	0.5	0.3	0.5
SC84A	A380	Remainder	3.0-4.0	1.3	7.5-9.5	0.5	0.1 max	1.0	0.5	0.3	0.5
SC84B	380	Remainder	3.0-4.0	2.0	7.5-9.5	0.5	0.1 max	1.0	0.5	0.3	0.5
SC114A	384	Remainder	3.0-4.5	1.3	10.5-12.0	0.5	0.1 max	1.0	0.5	0.3	0.5
SG100A	A360	Remainder	0.6 max	1.3	9.0-10.0	0.3	0.4-0.6	0.5	0.5	0.1	0.2
SG100B	360	Remainder	0.6 max	2.0	9.0-10.0	0.3	0.4-0.6	0.5	0.5	0.1	0.2

TABLE VI

MECHANICAL PROPERTIES OF ALUMINUM DIE-CASTING ALLOYS

Alloy designation		Condition	Yield strength 0.2% offset, psi	Ultimate strength, psi	Elongation, % in 2 in.	Compression yield strength, 0.2% offset, psi	Ball BHN 500-kg load, 10 mm	Shear strength, psi	Endurance limit, psi
ASTM	Commercial								
G8A	218	As cast	27,000	45,000	8.0	27,000	.....	27,000	23,000
S5C	43	As cast	16,000	30,000	9.0	16,000	.....	19,000	17,000
S12A	....	As cast	21,000	39,000	2.0	21,000	.....	25,000	19,000
S12B	13	As cast	.....	37,000	1.8	.....	.....	.....	.....
SC54A	....	As cast	24,000	40,000	5.0	24,000	.....	26,000	22,000
SC54B	85	As cast	22,000	38,000	5.5	22,000	.....	25,000	22,000
SC84A	A380	As cast	25,000	46,000	3.0	25,000	.....	29,000	19,000
SC84B	380	As cast	26,000	45,000	2.0	26,000	.....	29,000	20,000
SC114A	384	As cast	27,000	46,000	1.0	.....	.....	29,000	21,000
SG100A	A360	As cast	27,000	44,000	3.0	27,000	.....	28,000	19,000
SG100B	360	As cast	.....	43,000	3.0	.....	.....	.....	.....

TABLE VII

PHYSICAL PROPERTIES OF ALUMINUM DIE-CASTING ALLOYS

Alloy designation ASTM	Alloy designation Commercial	As cast	Annealed	Artificially aged	Solution heat-treated	Solution treated and aged	Specific gravity	Approximate solidification range, °F	Thermal conductivity at 25°C, CGS units	Coefficient of thermal expansion per °F X 10 68-212°F	Electrical conductivity, % of IACS
G8A	218	X	....	....	....	....	2.57	1150- 995	0.23	13.3	24
S5C	43	X	....	....	....	....	2.69	1175-1070	0.35	12.2	38
S12A, B	13	X	....	....	....	....	2.66	1085-1065	0.29	11.4	31
SC54A	....	X	....	....	....	....	2.78	1135- 970	0.27	11.6	28
SC54B	85	X	....	....	....	....	2.78	1135- 970	0.27	11.6	28
SC84A	A380	X	....	....	....	....	2.71	1100-1000	0.24	11.7	25
SC84B	380	X	....	....	....	....	2.72	1100-1000	0.23	11.6	23
SC114A	384	X	....	....	....	....	2.70	1080- 960	0.23	11.2	23
SG100A	A360	X	....	....	....	....	2.63	1095-1050	0.29	11.7	30
SG100B	360	X	....	....	....	....	2.64	1105-1035	0.27	11.6	28

TABLE VIII

TYPICAL TENSILE PROPERTIES OF SOME ALUMINUM DIE-CASTING ALLOYS AT ELEVATED TEMPERATURES

(After heating for ½ hour at testing temperature)

Alloy	Temp., °F	Strength, psi		Elongation, % in 2 in.	Alloy	Temp., °F	Strength, psi		Elongation, % in 2 in.
		Tensile	Yield (offset = 0.2%)				Tensile	Yield (offset = 0.2%)	
S12B (13)	75	39,000	21,000	2.0	SG100B (360)	75	44,000	27,000	3.0
	212	34,000	21,000	5.0		212	39,000	27,000	3.0
	300	30,000	19,000	7.0		300	34,000	25,000	4.0
	400	25,000	18,000	12.0		400	29,000	24,000	5.0
	500	19,000	13,000	20.0		500	21,000	17,000	9.0
S5C (43)	75	30,000	16,000	9.0	SC84A (A380)	75	46,000	25,000	3.0
	212	26,000	16,000	13.0		212	44,000	26,000	5.0
	300	23,000	15,000	16.0		300	38,000	23,000	7.0
	400	19,000	14,000	19.0		400	28,000	20,000	12.0
	500	14,000	10,000	23.0		500	20,000	14,000	15.0
SC54B (85)	75	40,000	24,000	5.0	SC84B (380)	75	45,000	26,000	2.0
	212	38,000	24,000	5.0		212	43,000	28,000	3.0
	300	33,000	22,000	7.0		300	37,000	25,000	4.0
	400	24,000	19,000	10.0		400	29,000	22,000	5.0
	500	17,000	13,000	16.0		500	20,000	15,000	10.0
G8A (218)	75	45,000	27,000	8.0	SC114A (384)	75	46,000	27,000	1.0
	212	40,000	25,000	12.0		212	44,000	28,000	2.0
	300	34,000	23,000	15.0		300	38,000	25,000	5.0
	400	25,000	19,000	18.0		400	28,000	22,000	8.0
	500	16,000	12,000	22.0		500	20,000	16,000	12.0
	75	41,000	23,000	5.0					
	212	36,000	23,000	6.0					
	300	32,000	21,000	8.0					
	400	27,000	20,000	11.0					
SG100A (A360)	500	20,000	15,000	15.0					

MAGNESIUM BASE DIE CASTINGS

Only two magnesium alloys are commonly die cast. The compositions are identical except for the allowable amount of copper as shown in Table IX.

Unlike many of the sand and permanent mold castings, die castings are not heat-treated.

Because magnesium alloys do not tend to solder to the steel dies, much smaller holes can be cored than is possible when casting aluminum. Also since magnesium does not react with iron it is possible to use hot chamber types of machines to produce the castings. This, of course, results in higher rates of production. In many cases magnesium and aluminum can be used interchangeably depending on the relative prices of the metals.

The physical properties of magnesium die castings are shown in Table X. Density is about one-third less than for aluminum, but both electrical and thermal conductivity are materially lower than most of the aluminum die castable alloys.

The mechanical properties given in Table XI show that die cast megnesium has an appreciably lower ultimate tensile strength, but almost as high a yield in tension, than aluminum die castings. Elongation of the two metals is about the same.

TABLE IX
CHEMICAL COMPOSITION OF MAGNESIUM DIE CASTING ALLOYS

ALLOY DESIGNATION	COMPOSITION				
	Mg	Al	Mn	Zn	Cu
AZ91A	Bal	9.0	0.20	0.60	0.10 max
AZ91B	Bal	9.0	0.20	0.60	0.30 max

TABLE X
PHYSICAL PROPERTIES OF MAGNESIUM DIE CASTING ALLOYS

Alloy	Sp. Gr. g/cc	Density lb/cu. ft.	Melting Point °F	Thermal Conductivity CGS Units	Electrical Resistivity microhm-cm.
AZ91A, AZ91B	1.81	0.066	1120	0.13	17.0

TABLE XI
MECHANICAL PROPERTIES OF MAGNESIUM DIE CASTING ALLOYS (as cast)

Alloy	Tensile Strength 1000 psi	Yield in Tension 1000 psi	Elongation % in 2"	Shear Strength 1000 psi	Brinell Hardness
AZ91A, AZ91B	33	22	3	20	67

Why you should use standard alloys when . . .

Designing For Investment Casting

BECAUSE ANY CASTABLE METAL or alloy can be investment cast, some designers tend to select the more rarely used materials. These give unique properties within a limited area. But they slow down production of the castings and increase part costs. How?

Since many of these materials are seldom used, the foundry has usually had only limited experience with them. This can lead to high initial rejects due to improper founding methods.

Again, because the metal or alloy is seldom cast problems will arise in the melt shop. Scheduling must be interrupted to free one or more melting furnaces for the material instead of allowing the pouring when a fairly large number of different jobs in the same alloy are being poured.

In many cases these special metals and alloys are not available as melting stock. This means alloying in the furnace with the possibility of an off analysis heat. Certainly control costs, due to increased laboratory charges must be expected.

Inspection costs will always increase when an unfamiliar material must be cast. In many cases where the foundry normally uses statistical quality control methods they must substitute 100% inspection. The customer will have to pay for these increased costs.

Finally there is the problem of machining after the castings have been delivered. The average shop is set up to do standard machining. Any deviation increases costs. Many of these seldom used alloys require special tools or different rates of machining. All of these things increase costs.

But all of these factors that slow down production and increase costs can be avoided by sticking to the more frequently used metals and alloys. In this group, materials can be found which will give almost any combination of properties that are normally needed.

The following tables give the chemistry and mechanical properties of a group of 26 ferrous and non-ferrous alloys. These are probably the most commonly specified materials from which investment castings are made.

In the group of non-ferrous alloys, almost all of those listed are heat-treatable. This gives a wide range of strengths and hardnesses. Naturally, as these alloys are heat-treated to secure higher mechanical properties, there is some degredation of physical properties, notably conductivity and thermal expansion. Note also that some of the alloys are usable at elevated temperatures.

In the group of ferrous alloys, all except the austenitic stainless steels can be hardened by heat-treatment to achieve high mechanical properties. Materials in this group include steels which can be heat-treated to ultimate tensile strengths of nearly 200,000 psi and hardnesses approaching 60 R_c.

Only three of the cobalt base alloys are listed in the tables. There are, of course, many others and, since these are rather highly specialized materials it is probable that the general remarks above may not apply to these alloys to as great an extent as they do to the more common base alloys.

Tables of properties, pages 40-41

Designing for INVESTMENT CASTING

CHEMICAL ANALYSIS OF SPECIFICATIONS

Alloys	Alloy Type	Spec.	Si Min-Max	Mg Min-Max	Fe Max	Zn Min-Max	Cu Min-Max	Ti Min-Max	Mn Min-Max	Al Min-Max	Ni Max
Aluminum	356	AMS 4260	6.5-7.5	.20-.40	.50	.30	.20	.20	.30	Bal	
	A356		6.5-7.5	.25-.40	.15	.10	.10	.20	.10	Bal	
	X357		6.5-7.5	.45-.60	.15	.03	.05	.10-.20	.03	Bal	
	C612	(B108-52T, ZC60A)	.30	.25-.45	1.4	6.0-7.0	.35-.65	.20	.05	Bal	
Magnesium	AZ91C	(B80-56T, AZ91C) (QQM56-AZ91)	.30	Bal		.4-1.0	.10		.13	8.1-9.3	.01
	AZ92A	AMS 4434	.30	Bal		1.6-2.4	.10		.10	8.3-9.7	.01
	AM100A	(B80 56T, AM100A)	.30	Bal		.50	.10			9.3-10.7	.01
	HK31A	AMS 4445 (QQM56A-HK31A)		Bal							.01
	EZ33A	(B80-56T, EZ33A) AMS 4442		Bal		Nominal 3.0					
Copper Base	BeCu-20C	AMS 4890	.20-.30		.35	.10	Bal			.15	.20
	Si Bronze	QQ-C-593(-1)	1.0-5.0		2.5	5.0	Bal		1.5		

			C Min-Max	Mn Min-Max	P Max	S Max	Si Min-Max	Ni Min-Max	Cr Min-Max	Mo Min-Max	Cu Min-Max	Fe Max
Carbon & Low Alloy Steel	1020	SAE 0022	.12-.22	.50-.90	.05	.06	.60					Bal
	4130	AMS 5336	.25-.35	.40-.80	.04	.04	1.0		.8-1.1	.15-.25		Bal
	8630	AMS 5334	.25-.35	.60-.95	.04	.04	1.0	.35-.75	.35-.65	.15-.25		Bal
	4140	AMS 5338	.35-.45	.75-1.0	.04	.04	1.0		.8-1.1	.15-.25		Bal
Stainless Steels Austenitic	303	AISI-303	.15	2.0	See Others		1.0	8.0-10.0	17.0-19.0	See Others		Bal
	304	AISI-304	.08	2.0	.04	.03	1.0	8.0-11.0	18.0-20.0			Bal
	347	AMS 5362	.12	2.0	.04	.03	1.0	10.0-14.0	18.0-19.5	.50	.50	Bal
	310	AMS 5366	.18	2.0	.04	.03	.50-1.5	19.0-22.0	23.0-26.0	.50	.50	Bal
Martensitic	410	AMS 5350	.05-.15	1.0	.04	.03	1.0	.50	11.5-13.5	.50	.50	Bal
	431	AMS 5353	.08-.15	1.0	.04	.03	1.0	1.5-2.2	15.0-17.0			Bal
	440C	AMS 5352	.95-1.2	1.0	.04	.03	1.0	.75	16.0-18.0	.35-.75		Bal
Precipitation Hardening	17-4 PH	AMS 5355	.08	1.0	.04	.04	1.0	3.0-5.0	15.5-17.5		3.0-5.0	Bal
Cobalt Type	Stellite 21	AMS 5385	.20-.30	1.0			1.0	1.75-3.75	25.0-29.0	5.0-6.0		3.0
	Stellite 31	AMS 5382	.45-.55	1.0	.04	.04	1.0	9.5-11.5	24.5-26.5			2.0
	N 155	AMS 5376	.20	1.0-2.0	.04	.03	1.0	19.0-21.0	20.0-22.5	2.5-3.5		Bal.

TYPICAL MECHANICAL PROPERTIES, SEPARATELY CAST TEST BARS

Sn Max	Others	Test Temp °F	Condition	Strength X1000 PSI Tens.	Yield	% El. in 1"	Comments
	.05 ea. .15 Total		T51	25	20	2	Most widely cast aluminum.
			T6	33	22	3	
			T6	40	30	5	Is rapidly displacing 356, easier to obtain properties.
			T7	34	24	4	
			T6	50	42	2	Latest high strength alloy, no specs.
	.05 ea. .15 Total		T5	32	25	4	Brazeable, full strength, also reached after 21 days from cast or brazed cond.
		70	As Cast	22	16	2	Second most widely used Mag. alloy.
		70	T4	33	15	7	
		70	T6	34	23	3	
		300	T6	22			
	.07 ea.	70	As Cast	20	10	1	Popular Mag. alloy, preferable to AZ91.
		70	T4	34	10	6	
		70	T5	20	11	2	
		70	T6	34	18	1	
		70	As Cast	22	16	2	Formerly known as Dow G, weldable, easiest alloy to obtain x-ray soundness.
		70	T4	29	17	4	
		70	T6	34	23	3	
		70	T61	34	17	1-0	
	Thorium 3.0, Zr .7	70	As Cast	22	10	12	Thorium rich alloy—excellent strength up to 700°F.
		70	T6	31	16	6	
		400	T6	26	14	17	
		700	T6	14	9	26	
	Rare Earths 3.0, Zr .5 min.	70	T5	22	16	3	Rare earth alloy — useable up to 600°F.
		400		21	10	21	
		600		12	8	50	
.10	Be 1.85-2.15		As Cast	80	30	15	Useable in all conditions.
	Pb .02 Max.		As Cast & Aged	90	50	15	Ideal casting alloy.
	Co .20-.65		Sol. Annealed	65	25	20	Highly recommended.
	Cr .10 Max.		Sol. Annealed & Aged	150	120	1	
2.0	Pb .5 Max, .50 Total		As Cast	60	26	15	One of the better castable Cu Base alloys.

Co Min-Max	Others						
			As Cast	60	30	20	Low strength steel, high ductility.
			Quench & Temp.	150	125	8	Heat treatable up to 150,000 T.S. with best combination of strength and elongation. Can be used interchangeably.
			Quench & Temp.	150	125	8	
			Quench & Temp.	180	160	3	Heat treatable to Rc52, elong. falls off.
	Zr or Mo, .6 Max. P, S, or Se, .07 Min.		As Cast	70	30	35	Standard free machining stainless 18-8 grade.
			As Cast	70	30	35	Standard 18-8 grade for corrosion resistance.
	Cb + Ta = 10xC, 1.5 Max		As Cast	70	30	35	18-8 grade with Cb to minimize C precipitation at grain boundries due to welding.
			As Cast	70	30	35	High alloy content for oxidation resistance up to 2000 F.
			Quench & Temp.	180	150	8	Heat treatable "stainless" up to Rc38.
	N .03-.12, C + N .22 Max		Quench & Temp.	170	130	2	Heat treatable "stainless" up to Rc48.
			Quench & Temp.	—	—	—	Heat treatable "stainless" up to Rc58.
	Cb + Ta .45 Max		Aged	180	150	6	Heat treatable stainless up to Rc40, by aging from solution annealed cond. Minimum distortion during H.T.
Bal	B — .007 Max	1500		52		10	High strength up to 1500°F.
Bal.	W — 7.0-8.0	1500		35		6	High strength up to 1500°F.
18.5-21.5	W 2.0-3.0 Cb .75-1.25 N .10-.20	1500		45		15	Possesses higher ductility.

ALLOYS For greater **economy** and ***faster*** delivery, the above 26 standard alloys are recommended. Other alloys are available, consult with your caster. Over 60 alloys are currently being cast.

When designing for permanent mold castings use these . . .

Properties of Permanent Mold Casting Alloys

TABLE I

CLASSIFICATION OF ALUMINUM PERMANENT MOLD CASTING ALLOYS BY TYPE OF APPLICATION

Application	ASTM Alloy Designation	
General-purpose alloys	CS42A SC64B SC64C	
General purpose alloys where pressure-tightness is required	CS72A S5A SC64A	SC51A SG70A
Alloys for architectural and decorative purposes	S5A GS42A GZ42A SG70A	ZC60A ZC81B ZG32A ZG42A
Alloys with high resistance to corrosion	S5A S5B GZ42A SG70A	ZC81B ZG32A ZG42A
Alloys retaining strength at elevated temperatures	CG100A CN42A SN122A	SC51A CS104B SC122A
Piston alloys	CG100A CN42A CS66A	SN122A SC122A

ALUMINUM BASE ALLOYS

PERMANENT MOLD CASTING offers the designer all of the advantages of sand casting in choice of alloy. It permits as great, or greater flexibility of coring, gives a stronger, sounder casting with a far superior surface finish and much closer dimensional accuracy. The reproducibility, from casting to casting is much better than can be secured in sand and, because of greater as-cast accuracy, much less machining allowance is needed.

While the designer may want to pick a specific alloy for a part, depending on physical or mechanical properties, the listing given in Table I is a good general outline of current alloy application. It serves as an adequate starting point in alloy selection.

The chemistry of the permanent mold castable alloys is wide. Many of the alloys available are heat-treatable to get better mechanical properties than are found in the as-cast condition. The composition of most of the more commonly cast alloys is given in Table II. This list is not complete since special purpose materials are constantly being developed. An example is the sodium-beryllium modified alloy Tens-50, a refinement of alloy SG70A (356).

The physical properties of the different alloys will, of course, vary widely as the chemistry is altered. Table III gives the more commonly needed physical

TABLE II

CHEMICAL COMPOSITION OF ALUMINUM PERMANENT-MOLD-CASTING ALLOYS

Alloy designation ASTM	Alloy designation Commercial	Aluminum, %	Copper, %	Iron, %	Silicon, %	Manganese, %	Magnesium, %	Chromium, %	Zinc, %	Titanium, %	Nickel, %	Other elements, % Each	Other elements, % Total
CG100A	122	Remainder	9.2-10.8	1.5	2.0	0.5	0.15-0.35	—	0.5	0.2	0.3	—	0.3
CN42A	142	Remainder	3.5-4.5	1.0	0.7	0.3	1.2-1.8	0.2	0.3	0.2	1.7-2.3	0.05	0.15
CS42A	B195	Remainder	4.0-5.0	1.2	2.0-3.0	0.3	0.05	—	0.3	0.2	0.3	—	0.3
CS66A	152	Remainder	5.5-7.5	1.5	5.0-6.0	0.8	0.2-0.6	—	0.8	0.2	—	—	0.8
CS72A	113	Remainder	6.0-8.0	1.4	1.0-4.0	0.5	0.07	—	2.5	0.2	0.3	—	0.5
CS104A	138	Remainder	9.0-11.0	1.5	3.5-4.5	0.5	0.5-1.5	—	0.5	0.2	1.0	—	0.5
GS42A	B214	Remainder	0.3	0.6	1.4-2.2	0.8	3.5-4.5	0.2	0.3	0.2	—	0.05	—
GZ42A	A214	Remainder	0.3	0.6	0.3	0.8	3.5-4.5	—	1.4-2.2	0.2	—	0.05	—
S5A	43	Remainder	0.1	0.8	4.5-6.0	0.3	0.05	—	0.3	0.2	—	0.05	—
S5B	43	Remainder	0.3	0.8	4.5-6.0	0.3	0.05	0.2	0.3	0.2	—	—	0.3
SC51A	355	Remainder	1.0-1.5	0.8	4.5-5.5	0.5	0.4-0.6	0.2	0.3	0.2	—	0.05	0.15
SC64A	A108	Remainder	4.0-5.0	1.0	5.0-6.0	0.5	0.1	—	1.0	0.2	—	—	0.5
SC64B	319	Remainder	3.3-4.3	1.0	5.5-7.0	0.5	0.1	—	1.0	0.2	0.3	—	0.5
SC64C	319	Remainder	3.0-4.5	1.2	5.5-7.0	0.8	0.5	—	1.0	0.2	0.5	—	0.5
SC122A	B132	Remainder	1.0-2.0	0.9	11.0-13.0	0.5-0.9	0.4-1.0	—	0.4	0.2	0.05	—	0.5
SG70A	356	Remainder	0.2	0.6	6.5-7.5	0.3	0.2-0.4	—	0.3	0.2	—	0.05	0.15
SN122A	A132	Remainder	0.5-1.5	1.3	11.0-13.0	0.1	0.7-1.3	—	0.1	0.2	2.0-3.0	0.05	—
ZC60A	C612	Remainder	0.35-0.65	1.4	0.3	0.05	0.25-0.45	—	6.0-7.0	0.2	—	0.05	0.15
ZC81B	Tenzaloy	Remainder	0.4-1.0	1.3	0.3	0.6	0.2-0.5	0.3	7.0-8.0	0.2	0.1	0.1	0.2
ZG32A	Ternalloy 5	Remainder	0.2	0.8	0.2	0.4-0.6	1.4-1.8	0.2-0.4	2.7-3.3	0.2	—	0.05	—
ZG42A	Ternalloy 7	Remainder	0.2	0.8	0.2	0.4-0.6	1.8-2.4	0.2-0.4	4.0-4.5	0.2	—	0.05	—

TABLE III

PHYSICAL PROPERTIES OF ALUMINUM PERMANENT MOLD CASTING ALLOYS (TYPICAL VALUES)

Alloy designation ASTM	Alloy designation Commercial	As cast	Annealed	Artificially aged	Solution heat treated	Solution treated and aged	Specific gravity	Approximate solidification range °F	Thermal conductivity at 25° C, CGS units	Coefficient of thermal expansion per °F X10^{-6} -212°F	Electrical conductivity % of IACS
CG100A	122	X	....	....	....	....	2.95	1160-1005	0.32	12.2	34
CN42A	142	....	....	X	....	....	2.81	1165- 995	0.32	12.5	34
CN42A	142	....	....	....	....	X	2.81	1165- 995	0.32	12.5	33
CS42A	B195	....	....	....	X	....	2.78	1160- 980	0.33	12.2	35
CS42A	B195	....	....	....	....	X	2.78	1160- 980	0.45	12.2	50
CS66A	152	X	....	....	....	....	2.89	1110- 930	0.24	....	24
SC72A	113	X	....	....	....	....	2.91	1165- 975	0.28	12.2	30
CS104A	138	X	....	....	....	....	2.95	1120- 940	0.25	11.9	25
GS42A	B214	X	....	....	....	....	2.65	1170-1090	0.35	12.7	38
GZ42A	A214	X	....	....	....	....	2.65	1180-1050	0.32	13.3	34
S5A, B	43	X	....	....	....	....	2.69	1170-1065	0.34	12.3	37
S5A, B	43	....	X	....	....	....	2.69	1170-1065	0.39	12.3	42
SC51A	355	....	....	....	....	X	2.70	1160-1070	0.36	....	39
SC64A	A108	X	....	....	....	....	2.79	1140- 960	0.34	11.9	37
SC64B	319	X	....	....	....	....	2.77	1120- 950	0.28	....	29
SC64C	319	X	....	....	....	....	2.79	1120- 960	0.26	12.0	27
SC122A	B132	X	....	....	....	....	2.68	1060-1055	0.26	11.2	28
SG70A	356	....	....	....	....	X	2.68	1130-1075	0.38	11.9	41
SN122A	A132	....	....	X	....	....	2.72	1095-1000	0.28	10.5	29
ZC60A	C612	X	....	....	....	....	2.84	1190-1120	0.37	13.1	40
ZC81B	Tenzaloy	X									
ZG32A	Ternalloy 5	X	....	....	....	....	....	1175-1030			
ZG42A	Ternalloy 7	X	....	....	....	....	....	1170-1020			

TABLE IV

MECHANICAL PROPERTIES OF ALUMINUM PERMANENT MOLD CASTING ALLOYS (TYPICAL VALUES)

Alloy designation ASTM	Alloy designation Commercial	Condition	Yield strength 0.2% offset, psi	Ultimate strength, psi	Elongation % in 2 in.	Compression yield strength, 0.2% offset, psi	Ball BHN 500-kg load, 10 mm.	Shear strength psi	Endurance limit, psi
CG100A	122	Artificially aged	35,000	37,000	0.5	40,000	115	27,000	8,500
CG100A	122	Solution heat-treated and aged	36,000	48,000	0.5	36,000	140	30,000	9,000
CN42A	142	Artificially aged	34,000	40,000	1.0	34,000	105	26,000	10,500
CN42A	142	Solution heat-treated and aged	42,000	47,000	0.5	46,000	110	31,000	9,500
CS42A	B195	Solution heat-treated	22,000	37,000	9.0	22,000	75	30,000	9,500
CS42A	B195	Solution heat-treated and aged	26,000	40,000	5.0	26,000	90	32,000	
CS42A	B195	Solution heat-treated and aged	20,000	39,000	4.5	20,000	80		
CS66A	152	Artificially aged	16,000	29,000	1.0	16,000	95	22,000	
CS72A	113	As cast	19,000	28,000	2.0	19,000	70	23,000	
CS104A	138	As cast	24,000	32,000	1.5	32,000	100	22,000	
GZ42A	A214	As cast	16,000	27,000	7.0	17,000	60	22,000	
SC51A	355	Solution heat-treated and aged	27,000	43,000	4.0	27,000	90	30,000	9,000
SC64A	A108	As cast	16,000	28,000	2.0	16,000	70	25,000	
SC64B	319	As cast	19,000	34,000	2.5	19,000	85	24,000	
SC64B	319	Solution heat-treated and aged	27,000	40,000	3.0	27,000	95		
SC64C	319	As cast	19,000	26,000					
SC82A	327(SAE)	Solution heat-treated and aged	40,000	49,000	3.0	....	97		
SC122A	B132	Solution heat-treated	27,000	41,000	2.5	27,000	90		
SC122A	B132	Artificially aged	26,000	40,000	0.3	26,000	97		
SC122A	B132	Solution heat-treated and aged	38,000	43,000	1.0	38,000	92		
SG70A	356	Solution heat-treated and aged	27,000	40,000	5.0	24,000	90		
SN122A	A132	Artificially aged	28,000	36,000	0.5	28,000	105	24,000	
SN122A	A132	Solution heat-treated and aged	43,000	47,000	0.5	43,000	125	27,000	
ZC60A	C612	Aged	....	28,000	7.0				
ZC81B	Tenzaloy	As cast	....	33,000	3.0				
ZG32A	Ternalloy 5	As cast	15,000	33,000	22.0	....	55		
ZG32A	Ternalloy 5	Artificially aged	21,000	42,000	18.0	....	70		
ZG42A	Ternalloy 7	Artificially aged	29,000	47,000	8.0	....	95		
ZG42A	Ternalloy 7	Solution heat-treated	36,000	49,000	9.5	....	95		
ZG42A	Ternalloy 7	Solution heat-treated and aged	43,000	53,000	6.5	....	95		

TABLE V

TYPICAL TENSILE PROPERTIES OF SOME ALUMINUM PERMANENT MOLD-CASTING ALLOYS AT ELEVATED TEMPERATURES

Alloy and temper	Temp., °F	Tensile strength psi	Yield strength psi	Elongation % in 2 in.	Alloy and temper	Temp., °F	Tensile strength psi	Yield strength psi	Elongation, % in 2 in.
CG100A, artificially aged only (122-T551)	75	37,000	35,000		SC51A, solution heat-treated and aged (355-T6)	75	43,000	27,000	4.0
	212	34,000	33,000			212	39,000	27,000	3.0
	300	30,000	27,000			300	33,000	27,000	2.5
	400	25,000	20,000	1.0		400	13,000	9,500	20.0
	500	18,000	12,000	3.0		500	7,500	5,000	40.0
	600	8,500	5,000	10.0		600	4,500	3,000	50.0
	700	5,000	2,500	25.0		700	3,000	2,000	60.0
SN122A, artificially aged only (A132-T551)	75	36,000	28,000	0.5	SC51A, solution heat-treated and stabilized (355-T71)	75	36,000	31,000	3.0
	212	35,000	25,000	1.0		212	32,000	28,000	3.0
	300	31,000	22,000	1.0		300	27,000	22,000	4.0
	400	26,000	15,000	2.0		400	13,000	9,500	20.0
	500	18,000	9,500	5.0		500	7,500	5,000	40.0
	600	10,000	4,000	10.0		600	4,500	3,000	50.0
	700	5,000	3,000	45.0		700	3,000	2,000	60.0
CN42A, artificially aged only (142-T571)	75	40,000	34,000	1.0	SG70A, solution heat-treated and aged (356-T6)	75	40,000	27,000	5.0
	212	40,000	34,000	1.0		212	29,000	24,000	10.0
	300	37,000	33,000	1.0		300	20,000	19,000	15.0
	400	26,000	21,000	2.0		400	10,000	8,500	40.0
	500	13,000	7,000	10.0		500	6,500	4,500	50.0
	600	8,000	4,000	30.0		600	4,000	2,500	60.0
	700	4,500	2,500	45.0		700	2,000	1,500	70.0
CS42A, solution heat-treated and aged (B195-T6)	75	40,000	26,000	5.0	SG70A, solution heat-treated and aged (356-T7)	75	33,000	24,000	5.0
	212	35,000	23,000	5.0		212	28,000	22,000	10.0
	300	29,000	23,000	5.0		300	20,000	19,000	15.0
	400	17,000	11,000	15.0		400	10,000	8,500	40.0
	500	7,000	4,000	25.0		500	6,500	4,500	50.0
	600	3,500	2,500	75.0		600	4,000	2,500	60.0
	700	2,500	1,500	100.0		700	2,000	1,500	70.0

constants of the alloys. The properties given are for the condition (i.e. as-cast, annealed, aged, etc.) in which each alloy is usually used.

As with the physical properties, the mechanical properties of these alloys varies over a wide range. Within the group of alloys listed in Table IV, and the heat-treatments given, alloys can be found which will give the properties desired for any application of an aluminum casting.

Because permanent mold casting is highly economical for short run production, it has found wide acceptance in the aircraft and missile fields as a fabricating method. For these applications and for such non-military uses as gas turbines, for example, the elevated temperature properties of the castings become important.

In Table V are given some of the high temperature properties of those alloys which can be used in these services. Note that in the case of permanent mold alloys there are several that retain useful strengths up to 700°F. This is in contrast to the aluminum die casting alloys that have an upper limit around 500°F.

TABLE VI

COMPOSITION OF MAGNESIUM PERMANENT MOLD CASTING ALLOYS

ASTM Alloy	Aluminum %	Manganese %	Zinc %	Zirconium %	Rare Earths %	Tin %	Magnesium %
AM80A	8.5	—	—	—	—	—	Balance
AM100A	10.0	—	—	—	—	—	Balance
AZ63A	6	0.25	3	—	—	—	Balance
AZ91C	8.7	0.20	0.7	—	—	—	Balance
AZ92A	9	0.15	2	—	—	—	Balance
EK30A	—	—	—	0.35	3	—	Balance
EK41A	—	—	—	0.7	4	—	Balance
EZ33A	—	—	2.7	0.7	3	—	Balance
ZK51A	—	—	4.6	0.75	—	—	Balance
ZK61A	—	—	6.0	0.80	—	—	Balance

MAGNESIUM BASE ALLOYS

Magnesium permanent mold castings have, in general, the properties of magnesium sand castings with the added advantage of superior surface, better dimensional tolerances and usually a somewhat sounder structure.

There are ten different alloys of magnesium generally used in permanent mold casting. All of them are heat-treatable to give better than as-cast properties. The composition of these alloys is given in Table VI.

The physical properties of the various alloys are given in Table VII. While densities show little change, such properties as thermal and electrical conductivity may vary greatly.

It is for differences in mechanical properties and response to heat treatment, however, that the different alloys have been developed. These room temperature mechanical properties are given in Table VIII. Note that the yield in tension may vary from alloy to alloy by a factor of almost 3 to 1 and ultimate tensile strength by 2 to 1. The few data which are

TABLE VII
PHYSICAL PROPERTIES OF MAGNESIUM PERMANENT MOLD CASTING ALLOYS

Alloy and temper	Specific gravity (75°F)	Density lb/cu in.	Melting point °F	Thermal conductivity cgs units (212-570°F)	Electrical resistivity, microhm-cm (68°F)	Maximum permanent growth in./in.
AM80A	1.80	0.065	1125	0.18		
AM100A	1.81	0.066	1100	0.17	15.0	
AZ63A-T6	1.83	0.067	1135	0.18	11.5	0.00021
AZ91C-T6	1.81	0.066	1120	0.17	17.0	0.00055
AZ92A-T6	1.82	0.066	1110	0.16	16.0	0 00032
EK30A-T6	1.79	0.065	....	0.25	6.9	-0.00007
EK41A-T5	1.81	0.066	....	0.25	6.6	
EK41A-T6	1.81	0.066	....	0.23	7.3	
EZ33A-T5	1.82	0.067	....	0.24	7.1	
ZK51A-T5	1.82	0.066	....	0.20		
ZK61A-T6	1.83	0.067				
AZ91A and AZ91B	1.81	0.066	1120	0.13	17.0	

available for yield in compression and for shear do not show any very great differences, but in some cases even the small changes may be sufficient to warrant a change in alloy.

Generally magnesium permanent mold castings may be used interchangeably with aluminum. They are about one-third lighter in weight and are less expensive to machine. They may not, however, be used without surface protection of some sort. Also magnesium, when in contact with another metal, usually requires some sort of non-conductive coating between the two metals to prevent electro-chemical action.

Magnesium castings respond readily to most joining methods. They may be welded with either gas or electric torches. In the case of gas welding only low stressed joints should be attempted. Arc welded joints, if properly stress relieved, are generally as strong as the parent metal. Spot, seam and flash welding can all be done under the proper conditions. Soldering is not recommended for magnesium, but magnesium alloys can be brazed most successfully. In every joining system that can be used for magnesium alloys, cleaning is absolutely essential. If possible, use chemical methods of cleaning.

More design data in PMM next month.

TABLE VIII
ROOM-TEMPERATURE MECHANICAL PROPERTIES OF MAGNESIUM PERMANENT MOLD CASTING ALLOYS (SEPARATELY CAST TEST BARS)

Alloy	Condition	TS 1,000 psi	TSY 1,000 psi	Elongation, % in 2 in.	Bearing strength, 1,000 psi		Shear, 1,000 psi. min.	Hardness Brinell
					Ultimate	Yield		
AM80A	-F	29	14	6	...	...	...	46
	-T4	38	11	12	...	...	18	48
AZ92A	-F	24	14	2	50	46	16	65
	-T4	40	14	10	68	46	17	63
	-T5	25	17	1	50	46	16	80
	-T6	40	23	2	80	65	20	84
AZ63A	-F	29	14	6	60	40	16	50
	-T4	40	14	12	60	44	17	55
	-T5	29	15	4	60	40	17	55
	-T6	40	19	5	75	52	19	73
AZ91C	-F	24	14	2	60	40	16	52
	-T4	40	14	11	60	44	17	55
	-T6	40	19	4	75	52	19	73
EK30A	-T6	23	16	3	...	...	...	45
EK41A	-T5	23	16	1	...	...	...	45
	-T6	25	18	3	...	...	...	50
EZ33A	-T5	23	16	...	...	...	...	50
ZK51A	-T5	40	26	8	...	...	...	68
ZK61A	-T6	46	30	10	...	...	...	70
AM100A	-F	22	12	2	...	...	...	54
	-T4	40	13	10	...	...	...	52
	-T6	40	16	4	...	...	...	69
	-T61	40	22	1	...	...	...	

PMM

TECHNICAL REFERENCE FILE

APPROXIMATE COMPARATIVE PROPERTIES OF VARIOUS COMMONLY CAST MATERIALS

	Die Cast Zinc		Sand Cast Yellow Brass	Sand Cast Red Brass	Sand Cast Bronze	Cold Rolled Steel	Sand Cast Steel	Die Cast Aluminum	Die Cast Magnesium	Grey Iron	Malleable Iron
Brinell Hardness Number	82	91	40-50	50-55	50-80	137-207	115-130	60-80	60	179-269	110-145
Compressive Strength—pounds per square inch	60000	87000	—	—	41000-47000	—	—	—	—	65000-160000	—
Electrical Conductivity—mhos per cm. at 20°C.	157000	153000	162000	206000	69000	—	—	152000-238000	—	—	333000
Impact Strength—foot—pounds—Charpy	43	48	41	—	7-14	—	3-20	2-10	2 (IZOD)	—	16 Notched Bar
Melting Point —°C.	386.6	386.1	955	1021	960-965	—	—	—	—	—	—
Melting Point —°F.	727.9	727.0	1750	1870	1760-1770	—	—	1065-1165	1120	—	—
Modulus of Rupture—pounds per square inch	95000	105000	—	—	200000-300000	—	—	—	—	—	58000
Shear Strength—pounds per square inch	31000	38000	33000-43000	—	—	—	—	19000-29000	—	9000-59000	48000
Specific Gravity—grams per cc.	6.6	6.7	—	—	8.5-8.8	—	—	2.57-2.78	1.81	6.95-7.35	7.20-7.45
Specific Heat—calories per gram per °C.	0.10	0.10	0.09	0.09	—	—	—	—	—	—	0.122
Solidification Shrinkage—inches per foot	0.14	0.14	0.1875-0.250	0.1875	0.15	—	—	—	—	0.125	0.1875
Tensile Elongation—per cent	10	7	15-45	10-15	15-40	15-25	22-26	2-9	3	—	18-25
Tensile Strength—pounds per square inch	41000	47600	30000-45000	22000-28000	30000-45000	67000-102000	60000-90000	30000-46000	33000	35000-45000	53000-60000
Thermal Conductivity—cal./sec./sq.cm./cm./°C. at 18°C.	0.27	0.26	—	—	0.11	—	—	2.3-3.7	—	0.11	—
Thermal Expansion—per °C.—(0.0000 omitted)	274	274	199	187	—	—	110	—	—	100	120
Thermal Expansion—per °F. (0.0000 omitted)	152	152	—	—	102	065	—	114-133	—	062	066
Transverse Deflection—inches	0.27	0.16	—	—	—	—	—	—	—	0.20-0.37	—
Weight—pounds per cubic inch	0.24	0.24	0.29	0.31	0.31	—	0.28	0.095-0.101	0.066	0.26	—
Yield Point— pounds per square inch	—	—	14500	—	18000-21000	55000-87000	30000-55000	16000-29000	22000	—	32500-35000

PROPERTIES OF EXTRUDED ALLOYS—TABLE VIII

Compositions of extrudable ferrous alloys

Classification		Grade	C	Mn	Cr	Ni	Mo	V	W	Co	Ti	N
SAE Steels	Carbon	SAE 1020 SAE 1050	 .20	 .45								
	Alloy	SAE 4130 SAE 4340	.30 .40	.50 .70	.95 .80	 1.80	.20 .25					
Stainless Steels	Austenitic	Type 202 Type 304 Type 310 Type 316 Type 321 Type 347 AM-355	.15 max .08 max .25 max .10 max .08 max .08 max .12	9.00 2.00 max 2.00 max 2.00 max 2.00 max 2.00 max 1.00	18.00 19.00 25.00 17.00 18.00 18.00 15.50	5.00 9.00 20.00 12.00 10.50 10.50 4.50	 2.50 3.00				.40	.25 max .10
	Martensitic	Type 403 Type 410 Type 418Sp. Type 440C	.15 max .15 max .20 1.00	1.00 max 1.00 max .50 max 1.00 max	12.00 12.50 13.00 17.00	 .50 max 2.00	 .50 max .75 max		3.00			
	Ferritic	Type 430 Type 446	.12 max .20 max		16.00 25.00							
High Temperature Alloys		A-286 AL-807	.08 max .10	1.50	15.00 22.00	25.00 45.00	1.25 9.00			1.5	2.00	
	Carbon & Low alloy	Pompton Tioga	1.00 .68	.60 .60	.65 .65	1.40 1.40	.20 .20					
	Shock Resisting	Atlas 93 Seminole Hard	.55 .52	.55	.65 1.30		.35	.25	2.25			
	Cold Work	Ontario Huron	1.50 2.00	12.00 12.00		.80	.90 1.00					
	Hot Work	Atlas B Mohawk	.40 .45	3.00 3.50			.45 .70	12.00 14.00				
	High Speed	DBL-2 VLM	.80 .85	4.00 4.00		5.00 8.00	2.00 2.00	6.00				

TECHNICAL REFERENCE FILE

FERROUS AND NON-FERROUS POWDERED METAL DENSITIES

(FACTOR EASILY COMPUTES LBS. PER M PCS. FROM VOLUME OF PART IN CUBIC INCHES.)

	DENSITY		DENSITY PERCENT OF WROUGHT MATERIAL			
A	B	C				
Gms. C/C	Gms. In.³	Lbs. In.³	Iron Base SAE Type 2, 6, 3, 5, 7	Brass SAE Type 4	Bronze SAE Type 1	Factor*
4.7	77.0	.170	—	—	53.5**	170
5.6	91.7	.202	71.2	—	—	202
5.7	93.4	.206	72.4	—	—	206
5.8	95.0	.210	73.7	—	—	210
5.9	96.6	.213	75.0	—	—	213
6.0	98.3	.217	76.3	—	—	217
6.1	99.9	.220	77.6	—	—	220
6.2	101.6	.224	78.8	—	—	224
6.3	103.2	.228	80.1	—	71.8	228
6.4	104.8	.231	81.4	—	73.0	231
6.5	106.5	.235	82.7	—	74.1	235
6.6	108.1	.238	83.9	—	75.2	238
6.7	109.7	.242	85.2	—	76.4	242
6.8	111.4	.246	86.4	—	77.5	246
6.9	113.0	.249	87.7	—	78.7	249
7.0	114.7	.253	89.0	—	80.0	253
7.1	116.3	.257	90.3	81.7	81.0	257
7.2	117.9	.260	91.5	82.8	82.1	260
7.3	119.6	.264	92.8	84.0	83.2	264
7.4	121.2	.267	94.1	85.1	—	267
7.5	122.8	.271	95.4	86.3	—	271
7.6	124.5	.275	96.6	87.4	—	275
7.7	126.1	.278	—	88.6	—	278
7.8	127.8	.282	—	89.7	—	282
7.87	128.9	.284	100.0	—	—	284
7.9	129.4	.285	—	90.9	—	285
8.0	130.9	.289	—	92.0	—	289
8.7	142.5	314	—	100.0	—	314
8.78	143.8	317	—	—	100 0	317

**Filters

CONVERSION FIGURES

A = GRAMS PER CUBIC CENTIMETER B = GRAMS PER CUBIC INCH C = POUNDS PER CUBIC INCH

KNOWN		FIND
C	–	B = C x 454
C	–	A = C x 27.68
B	–	C = B x .00220462
B	–	A = B x .061
A	–	B = A x 16.38
A	–	C = A x .03613

LBS. PER 1000 PCS. FROM A GIVEN VOLUME

Lbs. per M pcs equals volume of part in in.³ x applicable factor* for required density.

EXAMPLE: A part with a cubic content of .250 inches³ at a density of 6.0 grams c/c will weigh (.250 in.³ x 217) 54.2 lbs. per M pcs. At a density of 6.5 grams c/c, the same part will weigh (.250 in.³ x 235) 58.75 lbs. per M pcs.

LBS. PER 1000 PCS. FROM A GIVEN WEIGHT IN GRAMS

When the weight of a part in grams is known, lbs. per M pcs. equals weight of part in grams x 2.2.

EXAMPLE: A part weighing 26.6 grams (26.6 x 2.2) will weigh, closely, 58.6 lbs. per M pcs.

Conversion data prepared by Nelson O. Schreiber, General Sintering Corp.

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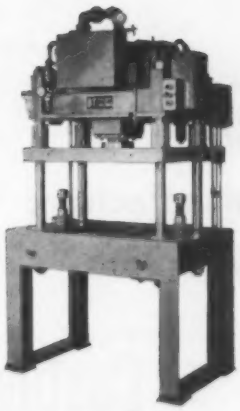

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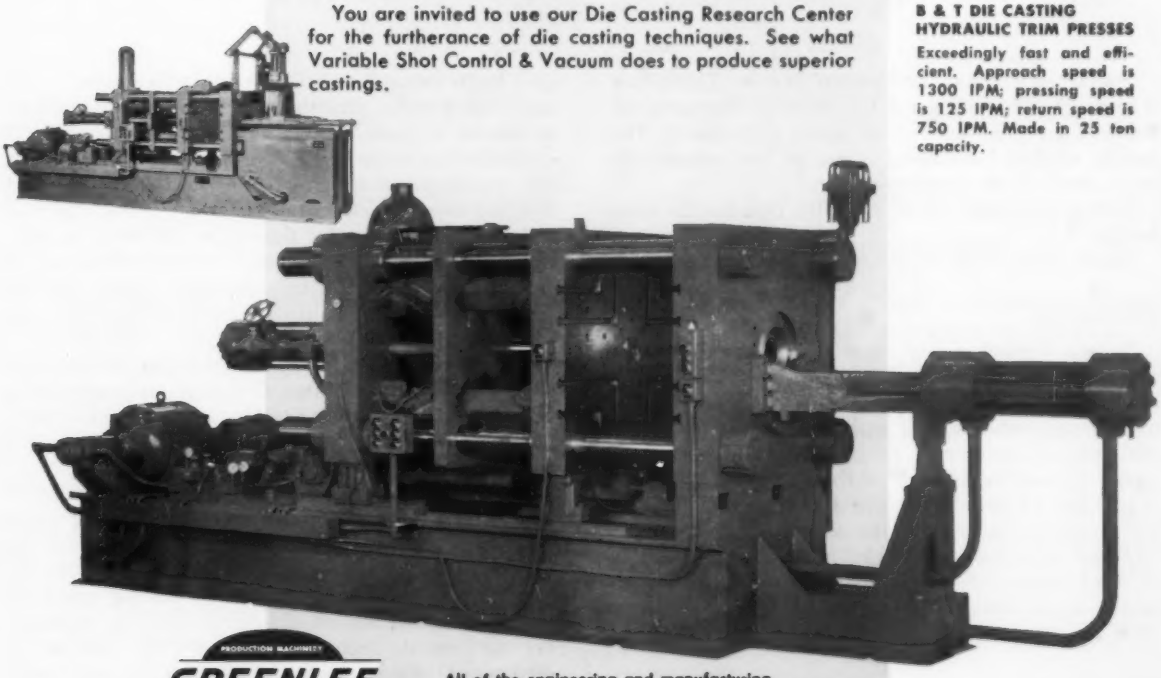

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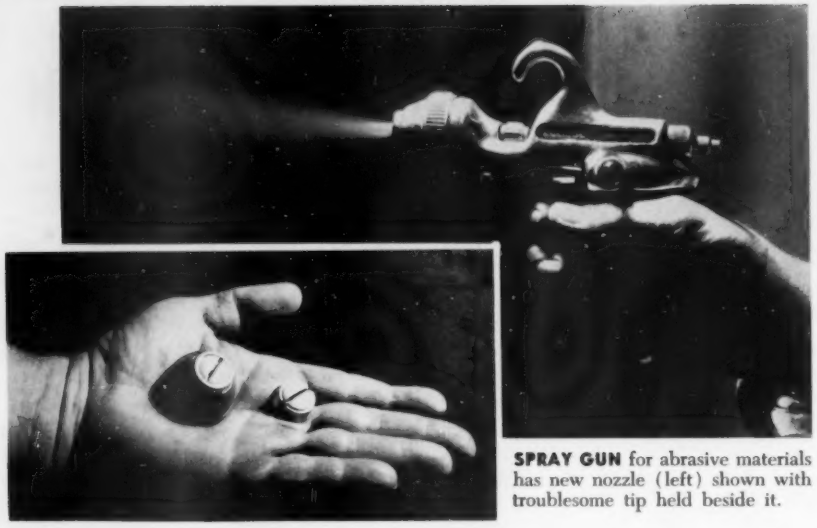
DESIGN FOR
INVESTMENT CASTINGS

Spray gun manufacturer finds that . . .



SPRAY GUN for abrasive materials has new nozzle (left) shown with troublesome tip held beside it.

Casting Outwears Tool Steel 25 to 1

SOLVE ONE PROBLEM and create another. That's how it was at Eclipse Air Brush Co. when its designers developed a revolutionary new spray gun nozzle. The nozzle worked beautifully — except that nozzle tips wore away at an alarming rate.

Today, tips made at one-third the cost last 25 times longer.

Here's how it all happened:

PROBLEM:

Eclipse wanted a new nozzle for spraying medium abrasive materials. It had to be more flexible, more dependable, and work better. A design was worked out in successive stages with aluminum prototypes until proved functional. In addition to abrasive materials, it could handle all but the fastest-drying fluids.

In fact, all problems were licked except one: to find a suitable material for the critical nozzle tip. Even tool steel wore out after several hours of spraying with abrasive cement wash. The search went on for a low-cost material that could withstand severe abrasion. Also, it had to be easy to form or shape.

SOLUTION:

The problem was taken to International Nickel Co., who suggested investment casting the tips in nickel-chrome white cast iron.

The suggestion worked.

The metal met specified mechanical requirements and, by investment casting, cost per unit was low. The metal has a matrix structure which, when mold cooled, is similar to heat-treated steel. It contains refined carbides that make it abrasive-resistant under wet or dry conditions. Furthermore, it has the fluidity and freezing range of cast iron.

As-cast tolerances for the nozzle tip were considerably closer than the normal foundry tolerances of $\pm.005$ in/in. And, the tip gets only routine quality control checks, such as the chemical analysis of every master heat before pouring.

The tip was X-rayed by in-line equipment during production of the pilot run. Dye penetrant equipment, tensile and stress-rupture testers, and an optical comparator also were available for examination and inspection.

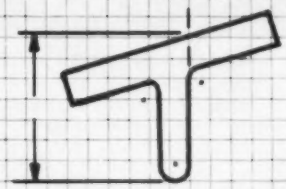
The new tip, 5/16 in. thick with ⅜-in. diameter, is one of three parts that make up the removable spray gun nozzle. It has three ports: one in the center for emitting the spray material and one on each side for directing air that controls the shape of the spray. In back, an annular pocket, or mixing chamber, separates the air currents and either atomizes the mixture or directs controlled amounts of air into the side ports. By adjusting the amount of air passing through these side ports, the spray can be regulated from a cone shape to a 15-in. fan.

The tip is secured by a retaining ring which fits into an aluminum housing, and the entire assembly screws onto the spray gun.

EXTRUSIONS

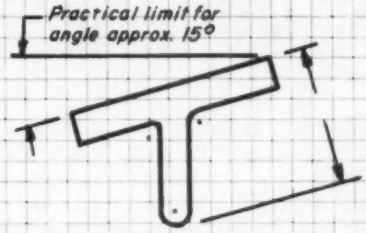
To insure getting extrusions the way you want them and at the lowest possible cost, use these suggested methods of dimensioning.

use these PMM **Design Tips** for lower costs -better products

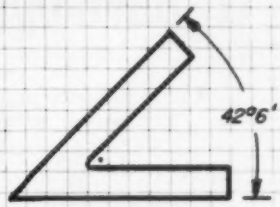


Not recommended

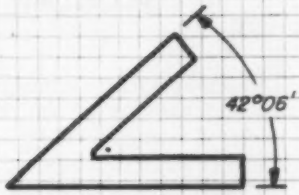
When check dimensions are needed for inspection, be sure to indicate them clearly, as shown. Dies cannot be built from such dimensioning.



Recommended



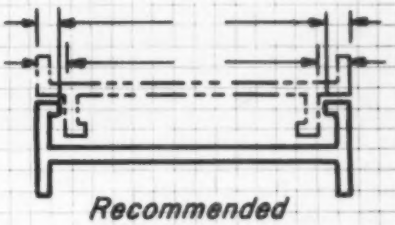
Recommended



Not recommended

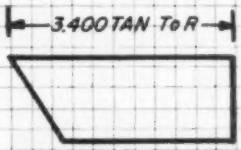
X	.300	.600	.900	1.200	1.500	1.800	2.100
Y	.192	.269	.260	.219	.145	.070	.027

Curved surfaces, not defined by radii, should be detailed by coordinates. With X and Y axis as shown, the curve is defined.

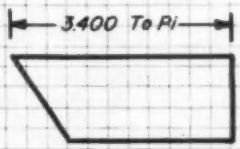


Recommended

When two, or more extrusions are to be assembled be sure to give all dimensions which directly affect the assembly.



0.031 R. All corners



0.031 R. All corners

When it is difficult to determine the exact point to which a dimension applies, note the point in the dimension rather than give an enlarged view. Here are two examples.

Exposed surfaces should always be shown and indicated by a medium light dashed line. The note exposed surface should be added as shown above.

Above material from "Drafting Standards" published by The Aluminum Extruded Products Div., The Aluminum Association

PORTABLE RECORDER is used for a variety of processes, and is wheeled from furnace to furnace to eliminate the need for instruments at each one.

A high order of flexibility and accuracy are needed in . . .

Research & Development Instruments

THE MEASUREMENT of temperature is one of the most critical problems in the investment casting industry. At every stage of the process, from the molding of the wax or plastic patterns, through the melting and casting of the metal, temperature control is essential.

This need for temperature measurement and control is common to all of the foundry industries, but there is probably no other founding method where there as many steps in the making of a casting where temperatures must be held within narrow limits. For example:

In the injection molding of the wax or plastic patterns any gross variation in temperatures can result in large dimensional differences from run to run and even from pattern to pattern.

In the melt out, too rapid a rate of heating can cause mold fracture, particularly where thin walls are encountered.

In the burn out, the wrong rate of heating or improper temperature may leave residues, generally of carbon, in the mold so that the metal can not fill properly. The wrong rate of heating between the melt out temperature and the burn out temperature can also result in mold breakage.

In mold pre-heating the wrong top temperature can result in uncontrolled cooling rates that lead to cracks, stresses, and dimensional inaccuracies.

In the metal temperature at pouring, the wrong temperature may result in unsoundness, incomplete filling of the mold, dimensional inaccuracy, excessive piping, and other well known foundry troubles.

Now precise as these controls and measurements must be, when a laboratory is set up for research and development and for the setting standards and procedures, the minimum level of temperature accuracy is that achieved in the production plant. For most laboratory purposes, however, this is not good enough.

In the new laboratory established by the Microcast Div. of Austenal, Inc. research and development work are constantly carried on. Standards and procedures for the producing units are set up and control tests on some types of production work are run.

The experimental burn-out furnace is used to establish plant practices for different types of waxes and plastics as well as for various investment materials. Since this furnace, a pusher type, must have several different temperature zones it is necessary to establish temperature limits for each zone. In fact, there are seven pairs of temperature recording points. The maximum spread of temperature is from ambient to 2000°F.

Heat treating and melting furnaces can present a still different problem and again the variation may be up to 3000°F.

On jet turbine blades and other critical aircraft parts the purchasers often require stress-rupture tests on specimens cast with each production run of parts. Temperature records of these tests are vital records.

These are only a few of the cases where a record of temperatures is essential. Naturally, a separate recorder could be established for each piece of equipment. This would be much too costly. Austenal, therefore, uses a 12 point Wheelco recorder mounted on a portable stand so that the instrument can be moved from place to place easily.

Because of the wide temperature spread encountered in normal work, the instrument is dual range. It is calibrated for chromel-alumel thermocouples in the range up to 2000°F and for platinum-platinum rhodium couples for temperatures from 1000°F to 3000°F.

Six of the thermocouple receptacles are for chromel-alumel couples and six for platinum. The two sets can be used interchangeably because 50 ft. compensated leads are used. This length of lead just about compensates for the different millivoltage produced by the two types of couples.

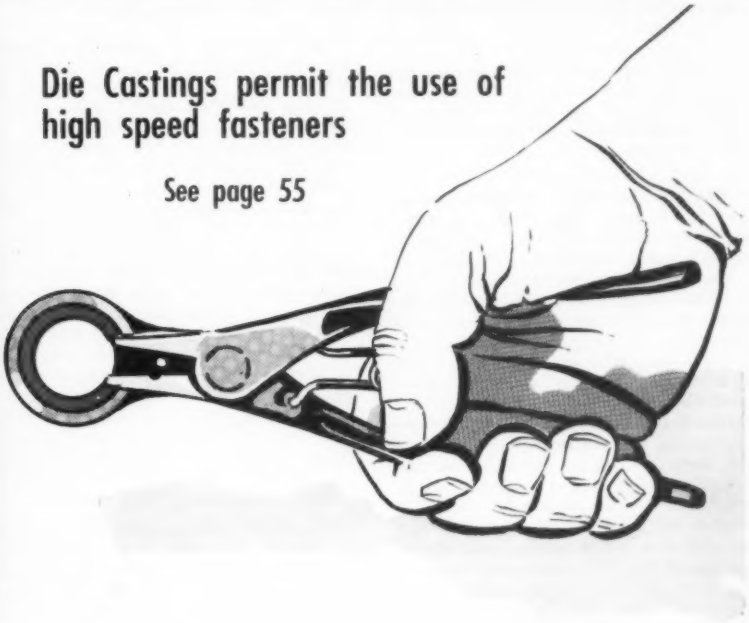
These uses are only a few of the many that this mobile recorder is called on to perform.

PMM Finishing Section

The specialized finishing methods, equipment and materials used to machine, assemble, surface condition or surface coat precision metal molded parts are presented here. This includes all secondary operations which convert a raw casting to a finished product.

Die Castings permit the use of high speed fasteners

See page 55



(Advertisement)

SPECIAL REPORTS ON FINISHING NON-FERROUS METALS

NUMBER III—Lustrous, Corrosion-Resistant Finishing with Chemical Polishing Iridite®

WHAT IS IRIDITE®?

Briefly, Iridite is the tradename for a specialized line of chromate conversion finishes. They are generally applied by dip, some by brush or spray, at or near room temperature, with automatic equipment or manual finishing facilities. During application, a chemical reaction occurs that produces a thin (.00002" max.) gel-like, complex chromate film of a non-porous nature on the surface of the metal. This film is an integral part of the metal itself, thus cannot flake, chip or peel. No special equipment, exhaust systems or specially trained personnel are required.

Chromate conversion coatings are widely accepted throughout industry as an economical means of providing corrosion protection, a good base for paint and decorative finishes for non-ferrous metals. Certain of these coatings also possess chemical polishing abilities that have luster-producing, as well as corrosion-inhibiting, effects on zinc and cadmium plate, zinc die castings and copper alloys. However, continued developments in this field have been so rapid that many manufacturers may not be completely aware of the breadth of application of this type of finish. Hence, this discussion of the many ways in which this chemical polishing characteristic can be used in final finishing or pre-plating treatments to produce a lustrous appearance with distinct display and sales appeal and appreciable savings in cost. Report I on decorative, corrosion-resistant finishes and Report II on paint base corrosion-resistant finishes are available on request.

The degree of luster possible on a surface is a function of the degree to which the surface can be smoothed. Leveling to provide a smooth surface can be achieved by mechanical or chemical means, or a combination of these, depending upon the luster desired and the original condition of the metal. Chemical polishing effectively imparts luster otherwise difficult and costly to obtain. For this reason, it is often used to supplement or entirely replace mechanical polishing, depending upon the application and the original condition of the metal. Chemical polishing has the additional advantage of providing overall treatment of the submerged part. It reaches into even the deepest corners and recesses that are otherwise inaccessible. Certain of the Iridites are specifically designed to perform this chemical polishing operation. Also, they provide corrosion protection as do all Iridites, thus may be used as a final finish or a pre-plating polish.

If Iridite is to be used as a final finish, in contrast to pre-plating treatment, the chromate conversion coating generated is allowed to remain, providing good corrosion resistance. Color inherent in these Iridite films ranges from a yellow cast to yellow iridescent. These coatings may be used without further treatment where this color is acceptable and good corrosion resistance is desired. Further, these basic coatings can be tinted by dyeing. Among the dye tints available are shades of red, yellow, blue and green. If desirable, the basic coatings can also be modified by a bleach dip leaving a clear bright or blue iridescent finish. In all cases bleaching reduces corrosion resistance.

As examples of this type of final finishing, Iridites #4-73 and #4-75 (Cast-Zinc-Brite) make possible for the first time, lustrous chemical polishing of the as-cast surface of zinc die castings. Thus, in many cases, sizeable savings in finishing cost are realized by elimination of plating costs. This economical method can be used on tools, appliance parts, toy pistols, locks and many other small castings. Another example is the treatment of copper and brass parts, such as welding tips, to eliminate buffing and provide additional corrosion resistance. In many cases, handling costs are reduced appreciably by replacing piece-part handling with bulk processing. Still another example of the use of this chemical polishing and protective quality of Iridite is a simple system of zinc plate, Iridite and clear lacquer instead of more costly electroplated finishes. Typical of this type of lustrous finish are builders hardware and wire goods.

As a pre-plating treatment, in contrast to final finishes, Iridite can be used to chemically polish zinc die castings or copper prior to plating. In such cases, Iridite should be applied as an in-process step, so that the protective film is removed before the plating cycle. The savings in handling, material and labor costs are obvious. This process has made it practical to plate chrome directly over copper on steel, conserving nickel, yet producing a lustrous chrome finish. Used after stripping faulty plate in reprocessing zinc die castings, Iridite restores luster to the casting, thus making possible replating without blistering.

Other Iridite finishes are available to produce maximum corrosion resistance, a wide variety of decorative finishes and excellent bases for paint on all commercial forms of the more commonly used non-ferrous metals. As a final finish, appearance ranges from clear bright to olive drab and brown and many films can be bleached or dyed. As a paint base Iridite provides excellent initial and retentive paint adhesion and a self-healing property which protects bare metal if exposed by scratching. Iridites have low electrical resistance. Some can be soldered and welded. The Iridite film itself does not affect the dimensional stability of close tolerance parts.

Iridites are widely approved under both Armed Services and industrial specifications because of their top performance, low cost and savings of materials and equipment.

You can see then, that with the many factors to be considered, selection of the Iridite best suited to your product demands the services of a specialist. That's why Allied maintains a staff of competent Field Engineers—to help you select the Iridite to make your installation most efficient in improving the quality of your product. You'll find your Allied Field Engineer listed under "Plating Supplies" in your classified telephone book. Or, write direct and tell us your problem. Complete literature and data, as well as sample part processing, is available. Allied Research Products, Inc., 4004-06 East Monument Street, Baltimore 5, Maryland.

For more information circle No. 93 on the Reader Service Card

Photos courtesy Reliance Div., Eaton Mfg. Co.

Design For Low Cost, High Speed Fasteners

WHEN YOU DESIGN die, permanent mold, or other types of castings, particularly castings of the softer metals, the method of fastening to be used in assembly is an important consideration. It means little to cut costs through the use of die castings, for example, if the savings are lost by slow, cumbersome, and expensive methods of fastening during assembly.

MANY TYPES AVAILABLE

The range of fastening devices which can be used with cast parts is wide. It includes many designs of push nuts, self tapping and thread cutting screws, lock washers, drive pins, snap rings, rolled spring pins and others. Four commonly used types are shown above.

SNAP RINGS

To prevent movement of gears, idlers, etc. along a shaft common practice is to provide a shoulder against which the free member can bear. On a machined shaft this can represent a considerable amount of machining and even when the shoulder is cast on, machining must still be done. Simpler, faster and cheaper is to provide a relatively shallow groove to position a snap ring. Assembly can be made easier, there is far less machining and no appreciable scrap loss.

PREASSEMBLED TYPES

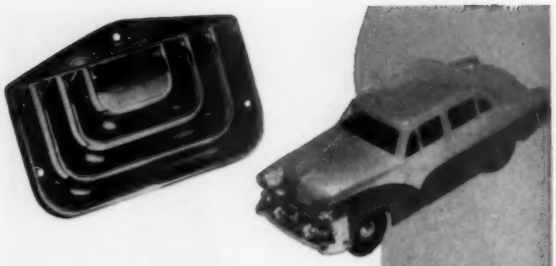
Preassembled nuts and lock washers require a threaded stud, or bolt, but speed assembly by requiring only one motion and one hand to apply both units. The lock washer is free to turn but can't come off. The sharp, spring steel locking edges dig into the metal parts being assembled to prevent loosening even under severe vibration.

SELF TAPPING SCREWS

Self tapping and thread cutting screws, particularly those with a preassembled lock washer save time in both machining and in assembly. In many cases the screw holes can be cored in die castings. Even when the holes must be drilled, the tapping operation is saved. Assembly can be a one hand operation.

LOCK WASHERS

Spring lock washers are made in a wide variety of shapes, each designed for a particular type of job or a specific type of material. Vibration, ductility of metal, expansion, contraction and wear tend to loosen bolted assemblies. The right type of lock washer maintains constant tension in the bolt to keep the assembly tight.



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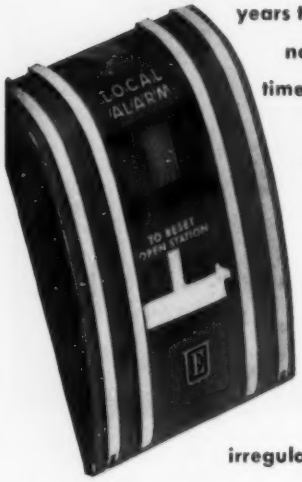

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- IF you want best possible results
- IF you want a minimum of rejections

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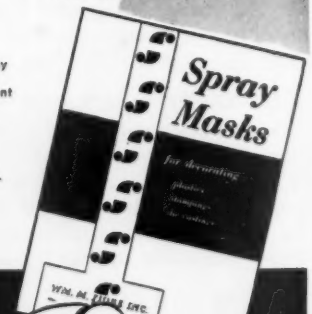

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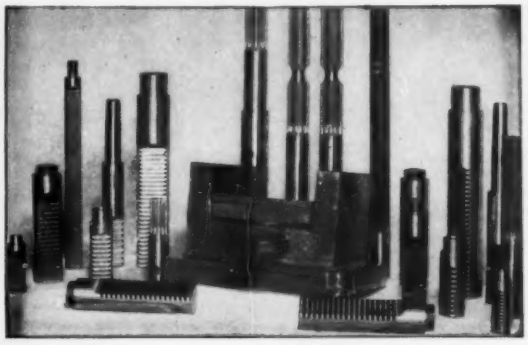

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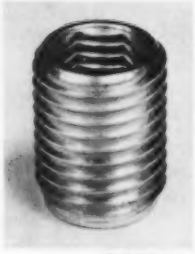

FIGURE 1.

. . . ELIMINATES THIS . . .

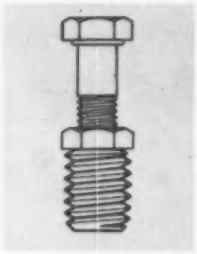

FIGURE 2.

IT WORKS LIKE THIS:

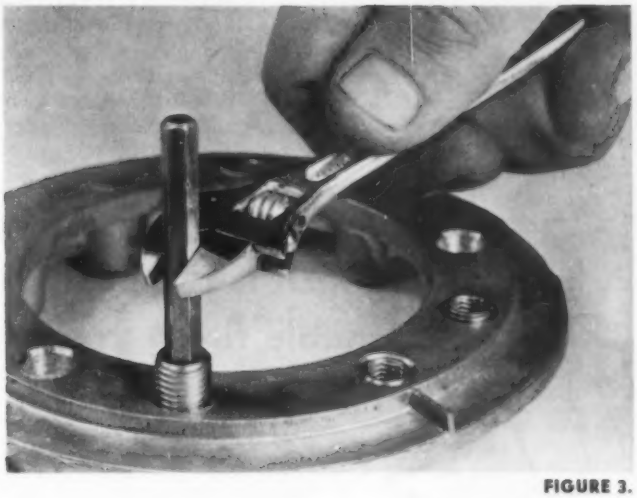

FIGURE 3.

Threaded Inserts for Soft Metal Castings

by MARVIN P. REECE*

FASTENERS TO BE USED with aluminum and magnesium castings need special attention. The metals are so soft that the threads often are damaged either by vibration or by frequently removing and replacing bolts. Studs often get around these difficulties. Inserts are another way.

Inserts generally have an internal and an external thread. The external thread holds the insert in the tapped hole in the soft part. The internal thread holds the fastener. The tougher insert metal takes the wear instead of the soft metal.

Proper and economical installation of inserts is a legitimate concern. Some inserts need special, expensive tools, which don't work well.

Rosan, Inc. developed a double selflocking insert called the U-Tap Inserto (Figure 1). Once you've screwed it into a soft metal casting, you can put bolts in an take them out as often as you like. The threaded fastener no longer allows any wear on the casting. In fact, most of the wear is on the fastener, not the insert. Not only does the insert prevent wear and damage to the casting, but it also has an internal lock that prevents the fastening bolt or stud from working loose. An external lock prevents the insert from coming loose in the casting.

Most inserts are installed with a tool that screws into the internal thread. That means the insert can not be screwed into a casting any tighter than the tool is screwed into the insert (Figure 2). Furthermore, no matter how tightly you screw in the insert it has a tendency to be loosened when the tool is twisted out. Sometimes, the insert actually backs off with the tool.

The new insert is screwed into place with a simple hexagonal bar similar to an Allen wrench (Figure 3). The internal thread of the insert is broached to an hexagonal shape into which the bar fits. Because it is in no way tightened into the insert, the hex bar can be removed easily without danger of loosening the insert. The insert is locked into the casting so that it can not be removed without the hex wrench.

The internal hexagonal shape was designed for two reasons. First, it prevents binding between the tool and the insert. Second, the shape makes for rapid installation, manually or by machines.

The holding power of the threads is not weakened by broaching the internal hex shape. In fact, the thread area is reduced by less than 5%. In tension tests with standard AN-4 bolts, the bolt threads failed without damaging the insert.

The external thread has two different diameters, this makes an highly effective thread lock. The upper four threads are a few thousandths of an inch larger than the remaining threads. A smooth transition from the smaller thread to the larger prevents any difficulty in putting in the insert. These slightly larger threads do not distort the surface of the casting and hold tightly enough to resist loosening even by strong twisting.

*ROSAN, INC.

HEAT TREATMENT OF SINTERED IRON

continued from page 31

for carburizing in solid as well as liquid carburizers.

INFLUENCE OF ALLOYING ELEMENTS

Really high hardness values are difficult to obtain during case hardening of sintered parts made from unalloyed iron powders. There are a few ways to add alloying elements which will decrease the quenching speed and at the same time increase the depth of carburization. Such alloying elements are for example, Mn, Cr, Ni, Mo and Cu. The main problem is, however, to get a homogenous material because of the low diffusion rate of these alloying elements in iron. The material with best qualities in this respect is copper. Some results on iron powder containing 2% copper are shown in Table I.

UNEVEN DENSITY

When carburizing a sintered part, it is impossible to adjust the process for the differences in density within one part. A part with low and uneven density will be carburized in an uneven way causing uneven hardness and varying impact strength. Tools for pressing of parts intended to be carburized should, therefore, be designed to give as uniform density as possible.

SELECTION OF QUALITY AND HEAT TREATMENT

When selecting sintered parts to be hardened, follow these general rules:

- The density should not be lower than 7.0 g/cc and should preferably be between 7.2 and 7.3 g/cc.
- When parts are made weighing less than 30 grams and with a thickness less than ¼", sufficiently good results might be obtained with unalloyed powder. A cyanide bath hardening for about 30 minutes gives hardness values which may be measured.
- For larger parts, it seems economical to carburize in solid carburizers especially if high hardness is desirable. This pack carburizing should be made at 910°C (1670°F).
- When the carburized layer is more than 1 mm (.040"), the hardness increases very little and it is recommended to use copper additions for additional hardness.
- Parts with fairly thin sections that should have high impact strength are not recommended for copper additions. The cyanide bath hardening is generally carried out at 850°C (1560°F). Higher temperatures will give more rapid carburization, but also increase danger of changes in the shape.
- If the parts are pack carburized, the heat treatment must be done in a salt bath between 825-850°C (1510-1560°F). A slightly carburizing salt bath is to be preferred because the so called neutral salt bath generally is somewhat decarburizing. Annealing in muffle furnaces is not to be recommended because the parts will be oxidized easily.

The drawback in annealing in a salt bath is trapping of salts in the pores. This salt may sweat out after some time, mostly, of course, with parts of lower densities. Careful washing of the parts in alternatively hot and cold water may solve this problem.

One of the greatest difficulties in hardening of sintered parts is to control the dimensional changes. Both growth and shrinkage may to some extent be controlled by the depth of carburization, but it has sometimes proven itself economical when tolerances are very narrow to control the dimensions with a grinding after hardening.

Which is the best way to tumble finish your parts?

That depends on the size of your part, its shape and how intricate its design. You must allow for the type of metal and whether the part has been stamped, cast or machined. The surface desired is another consideration. To make sure of the best way talk to a Grav-i-Flo engineer. No one in the tumbling business has more experience nor has acquired more knowledge.

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PARTS not suited to tumbling and previously finished only by buffing, are now finished to high lustre surfaces with Grav-i-Flo's new Spin-Finish machine.

These and all other variables of mechanical finishing make good reasons for calling Grav-i-Flo engineers for the answers to the *Best Way!*

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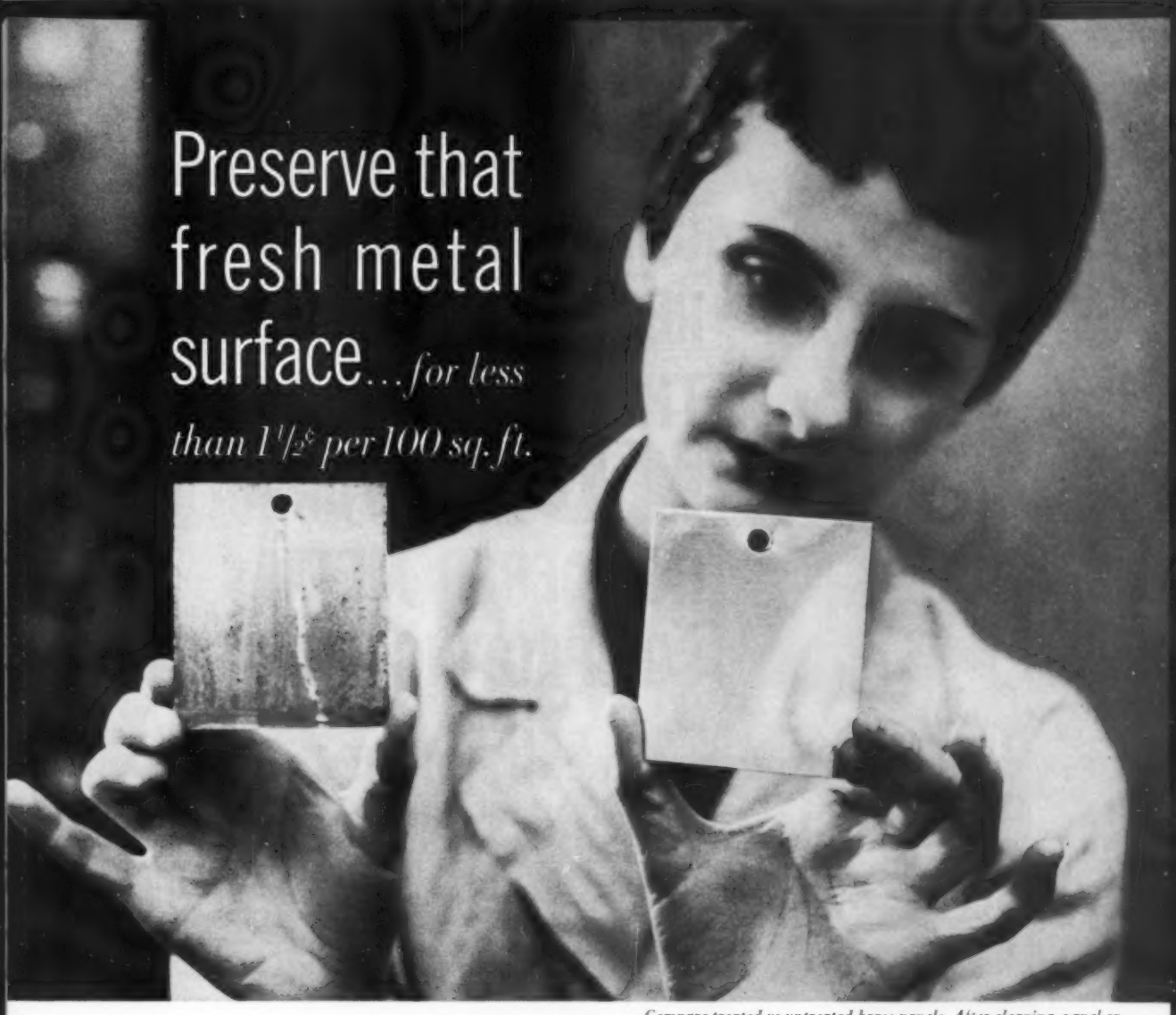

Compare treated vs untreated brass panels. After cleaning, panel on right was rinsed in Entek 45 rinse; panel on left, in standard hot water rinse. Then panels were exposed to 100% humidity at 100° F. for 100 hours. Note how Entek 45 preserves "that fresh metal surface."

From Enthonics research come Enthone Enteks, a new series of rinse water additives which coat metal surfaces with an "invisible shield" against the atmosphere. Entek 45 assures faster drying, eliminates water spots and provides lasting corrosion protection to all metals. Entek CU-55 prevents tarnishing and spotting out of copper and brass even under tropical humidity conditions.

By adding Entek 45 to your final hot water rinse, you can prevent white salt corrosion of zinc and aluminum, prevent yellowing of nickel plate, prevent tarnishing of copper and brass, prevent black spots on cadmium plate.

By treating copper and brass goods or copper or brass plated items with Entek CU-55 you can prevent tarnishing, green salt formation, spotting-out and pit corrosion under high humidity storage conditions.

Entek protection lasts for months, yet costs less than 1½¢ per 100 sq. ft. to treat your parts, less than ½¢ per gallon to make up an Entek 45 solution!

Entek 45 produces an invisible, water-repellent organic film on the metal surface which sheds water rapidly and promotes stain-free drying. This same film acts as an invisible barrier between the metal and the moisture and oxygen in the air.

Entek CU-55 reacts with copper and copper alloys to form an invisible layer which has many times the corrosion resistance of bare copper and brass. Additionally, this layer has better solderability and improves adhesion of lacquers and enamels.

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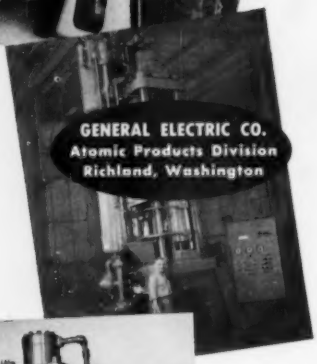

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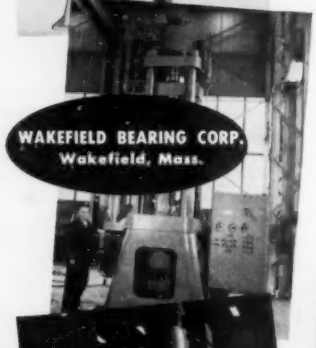

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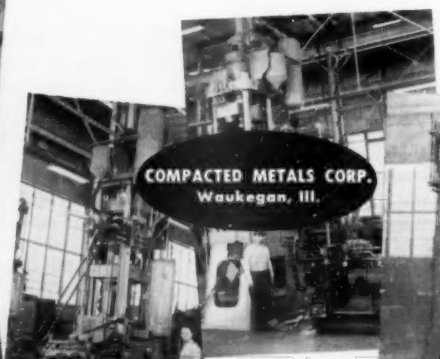

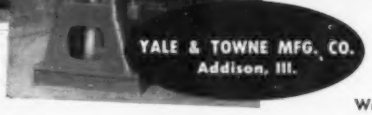

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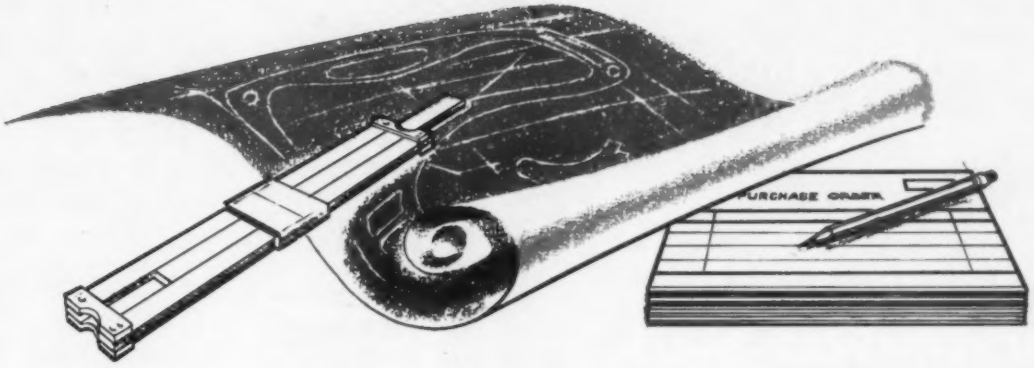

8th Annual

Powder Metallurgy DIRECTORY

The Economics Of Powder Metallurgy

ABOUT THE ONLY REASON for using powder metallurgy as a manufacturing method is because the parts made are cheaper. There are, of course, a great many components that can only be made as sinterings, but these are a small minority as far as type of part goes.

If, then, cost is the driving force, what are the factors which must be considered when deciding how to make a structural component.

PHYSICAL AND MECHANICAL PROPERTIES

First there's the question of physical and mechanical properties. Aside from function, these requirements have a large effect. If a part with only 80% density is adequate the cost will be the lowest. Let's call this cost 100. Now if properties are required that demand a density of over 95% of theoretical, then the cost jumps up to from 200 to 250. Or possibly a part infiltrated with either copper or brass is indicated, then the cost factor will be at least 175 and probably 200. So the first consideration is to SET PHYSICAL AND MECHANICAL REQUIREMENTS AT A REALISTIC LEVEL.

continued on page 107

	Non-powder	Sintering
Initial tooling	$	$
Raw Materials		
Jiggs & Fixtures		
Raw & semi-finished stock		
Total machining costs		(1)
Tool maintenance		
Intermediate stocking		
Finished material stocking		
Cost of inventories		(2)
Incoming inspections		
Intermediate inspections		(3)
Second operations	(4)	(5)
Heat treating		(6)
Surface finishing		
Capital expenditures	(7)	
Assembly costs		
Scrap losses		(8)
Final inspection		
Total cost less overhead	(9)	(9)

WHEN USING CHART, REMEMBER:

(1) This applied only to non-powder methods of fabrication.
(2) If finished parts go directly to assembly this is not a cost item.
(3) If no intermediate operations are performed there will be no intermediate inspections.
(4) For non-powder parts, this is included in total machining costs.
(5) In many cases the powder metal fabricator will do some or all of the second operations.
(6) Whenever possible the heat treating is done by the powder metal fabricator.
(7) This includes tools, building, etc. on which depreciation and tax deductions are taken.
(8) When no second operations are done, this may not be an item.
(9) Total costs must always be compared at exactly the same level of completion. Generally at assembly level or at final product level.

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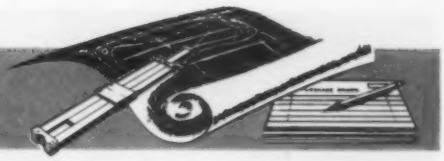

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Bound Brook Oil-less Bearing Co.
Brockway Pressed Metals, Inc.
Bunting Brass and Bronze Co.
Carbon City Products Co., Inc.
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Engineered Plastics, Inc.
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Indar Corp.
International Powder Metallurgy Co., Inc.
International Powder Metallurgy, Inc.
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Johnson Bronze Co.
Keystone Carbon Co.
Kwikset Powdered Metal Products
Merriman Bros., Inc.
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Mueller Brass Co.
National Molded Products, Inc.
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Precision Metal Products Co.
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Pure Carbon Co., Inc.
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Sintered Metals, Inc.
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Standard Carbon Co.
Sterling Engineering Corp.
Superior Carbon Products, Inc.
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Other Types

American Sinteel Corp.
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(special alloys)
Deva-Metal Div.
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Detroit Alum. & Brass Corp.
(copper-lead on steel)
Eaton Mfg. Co.
Powdered Metals Div.
(FeA1)
General Sintering Corp.
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Haller, Inc.
(cavity type)
Kwikset Powdered Metal Products
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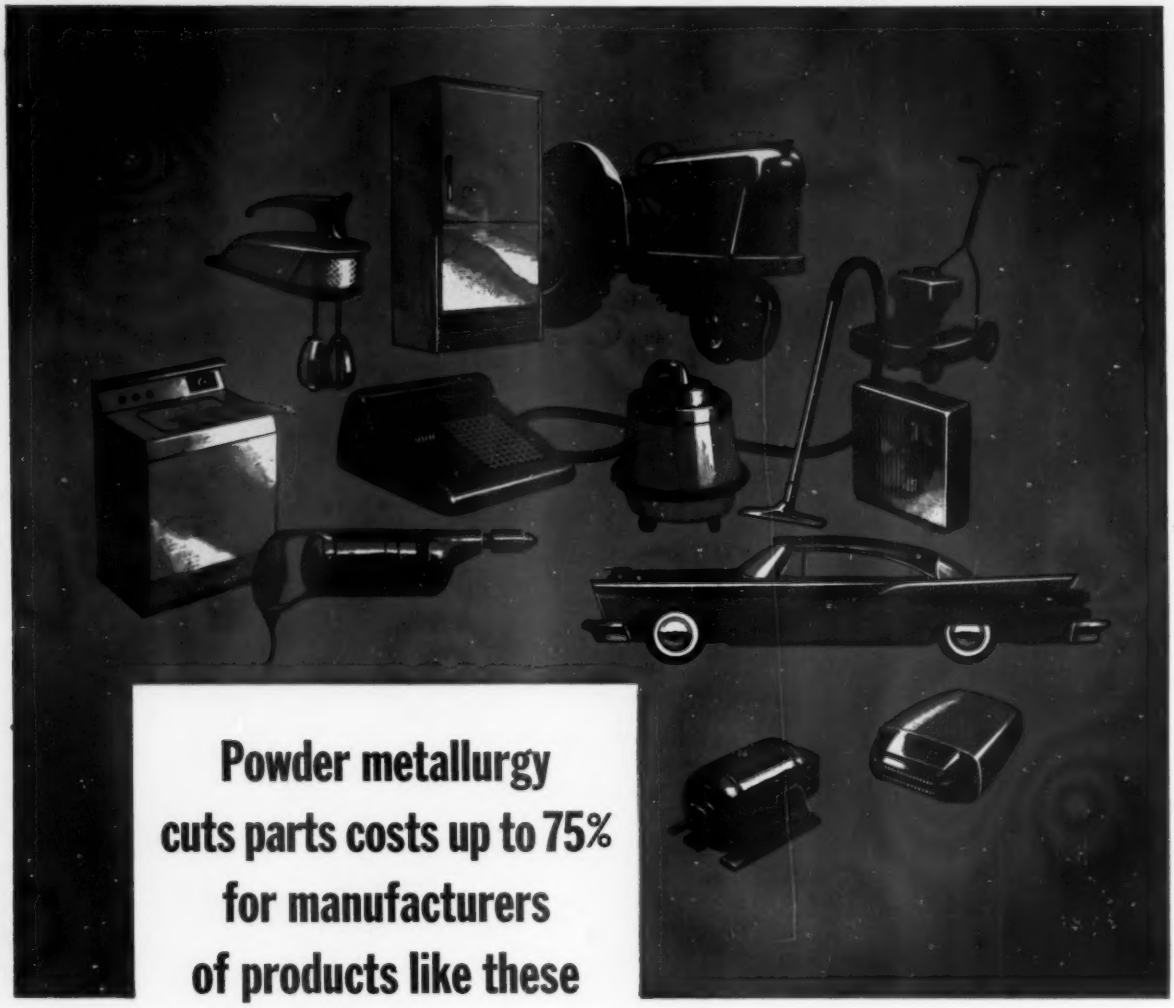

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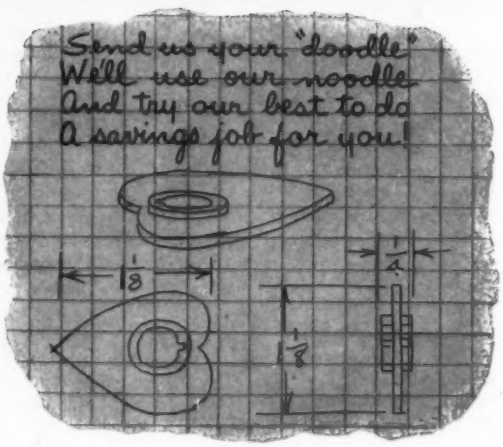
As a leading supplier of metal powders, Glidden works closely with parts producers. In this way, several staffs of experienced technicians may be at your disposal—to provide complete technical service and suggest possible design changes that may bring even lower parts costs.



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shoot in the lower position! mold vertically!

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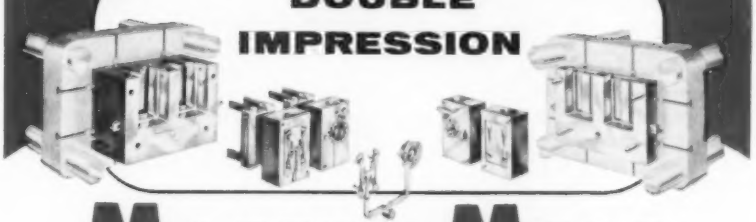

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Smooth surface finishes and close tolerances on long, high speed production runs are typical with Brockway Metal Parts. Because the production methods involved result in such amazing cost reductions, questions frequently arise concerning the true nature of pressed metals. Outlined below are those characteristics generally considered most important.

POROSITY may be controlled to range from 15% to 35% by volume. Pores can be sealed by special impregnation.

WELDING and brazing procedures are similar to those for cast metals. Complete knowledge of metallic-mixes enables Brockway to recommend best alloys for these purposes.

PEENING, riveting or swaging requirements should be specified. Brockway produces parts with the exact malleability needed for such processing.

SOLDERING of iron or bronze parts presents no problem so long as the parts have been thoroughly cleaned in advance.

DRILLING and tapping procedures generally follow those used for cast iron. Tool requirements should follow manufacturer recommendations.

GRINDING can be performed where necessary. Manufacturer's recommendations should be followed as to types of grinding wheels to be used.

REAMING can be done without sacrificing porosity of self-lubricating qualities by use of carbide tipped tools.

REMOVING OIL is accomplished by washing parts in good grade, commercial solvent or by burning in controlled atmosphere.

MACHINING is used as a secondary operation when desired shape cannot be obtained in the initial briquetting operation. Since machining tends to reduce porosity, bearing surfaces are not usually machined. Machining should be done without using a coolant so as not to interfere with the natural impregnation of the part.

PLATING of powdered metal parts produces excellent results so long as absorption of plating solution salts is guarded against. This is especially true with iron powder parts where the salts may cause internal corrosion.

BROCKWAY PRESSED METALS INC.
BROCKWAY, PA.

For more design information, send for our bulletin

Circle No. 89 on the Reader Service Card

Low Frequency

Aerovox Corp.
Crowley Div.
Arnold Engineering Co., The
Engineered Plastics, Inc.
American Sinterings Div.
Ferroxcube Corp. of America
Kwikset Powdered Metal Products
Magnetic Core Corp.
Micrometals
National Moldite Co.
Neosid (Canada) Ltd.
Norwalk Powdered Metals, Inc.
Powdercraft Corp.
Presmet Corp., The
Pyroferric Co., Inc.
Quality Components, Inc.
Radio Cores, Inc.

ELECTRICAL COMPONENTS

Collector Rings

American Powdered Metals, Inc.
Asco Sintering Corp.
Bunting Brass and Bronze Co.
Carbon City Products Co., Inc.
Chicago Powdered Metal Products Co.
Chrysler Corp.
Amplex Div.
Dixon Sintaloy, Inc.
Eaton Mfg. Co.
Powdered Metals Div.
Engineered Plastics, Inc.
American Sinterings Div.
Ferro Powdered Metals, Inc.
General Sintering Corp.
Gibson Electric Co.
Kwikset Powdered Metal Products
Metal Ceramics Powdered Metal Prod.
Powdercraft Corp.
Sintered Metals, Inc.
Superior Carbon Products, Inc.
United States Graphite Co., The
Div. of The Wickes Corp.
Wakefield Bearing Corp.

Commutator Segments

American Powdered Metals, Inc.
Asco Sintering Corp.
Carbon City Products Co., Inc.
Chicago Powdered Metal Products Co.
Dixon Sintaloy, Inc.
Eaton Mfg. Co.
Powdered Metals Div.
Eberhart Steel Products
Powdered Metals Div.
Engineered Plastics, Inc.
American Sinterings Div.
Ferro Powdered Metals, Inc.
General Sintering Corp.
Kruse & Slattery, Inc.
Kwikset Powdered Metal Products
Metal Ceramics Powdered Metal Prod.
Sintered Metals, Inc.
United States Graphite Co., The
Div. of The Wickes Corp.

Pole Pieces

Allegheny Ludlum Steel Corp.
Allied Products Corp.
Powdered Metal Parts Div.
American Powdered Metals, Inc.
Asco Sintering Corp.
Bunting Brass and Bronze Co.
Ceromet, Inc.
Chicago Powdered Metal Products Co.
Chrysler Corp.
Amplex Div.
Compacted Metals Corp.
Dixon Sintaloy, Inc.
Eaton Mfg. Co.
Powdered Metals Div.
Eberhart Steel Products
Powdered Metals Div.
Engineered Plastics, Inc.
American Sinterings Div.
Ferro Powdered Metals, Inc.
General Sintering Corp.
Haller, Inc.
Indar Corp.
International Powder Metallurgy Co., Inc.
International Powder Metallurgy, Inc. Rocky Mountain Metals Div., Inc.
Kruse & Slattery, Inc.
Kwikset Powdered Metal Products
Metal Ceramics Powdered Metal Prod.
Midwest Sintered Products Corp.
Moraine Products Div.
General Motors Corp.
Norwalk Powdered Metals, Inc.
Pacific Sintered Metals Co.
Powdercraft Corp.
Presmet Corp., The
Reese Metal Products Corp.
Sintered Metals, Inc.
United States Graphite Co., The
Div. of The Wickes Corp.
Wakefield Bearing Corp.

Rotor Segments

American Powdered Metals, Inc.
Asco Sintering Corp.
Brockway Pressed Metals, Inc.
Bunting Brass and Bronze Co.
Chicago Powdered Metal Products Co.
Compacted Metals Corp.
Dixon Sintaloy, Inc.
Eberhart Steel Products
Powdered Metals Div.
Engineered Plastics, Inc.
American Sinterings Div.
Ferro Powdered Metals, Inc.
General Sintering Corp.
Haller, Inc.
Kruse & Slattery, Inc.
Kwikset Powdered Metal Products
Metal Ceramics Powdered Metal Prod.
Powdercraft Corp.
Presmet Corp., The
Sintered Metals, Inc.
United States Graphite Co., The
Div. of The Wickes Corp.
Wakefield Bearing Corp.

Others

Allegheny Ludlum Steel Corp.
Cleveland Graphite Bronze
Div. of Clevite Corp.
(porous nickel battery plaques)
P. R. Mallory & Co., Inc.
(resistance welding—Elkonite)
Presmet Corp., The
(high conductivity copper)
Stackpole Carbon Co.
(Brushes—carbon, graphite slip ring, etc.)

FRICTION MATERIALS

American Brake Shoe Co.
Asco Sintering Corp.
(clutch facings)
Chrysler Corp.
Amplex Div.
(non-ferrous)
Ferro Powdered Metals, Inc.
(Cu Base)
General Metals Powder Co., The
Kwikset Powdered Metal Products
Moraine Products Div.
General Motors Corp.
(metallic, non-metallic, semi-metallic)
Powdercraft Corp.
(Cu Base)
Presmet Corp., The
(bronze)
Raybestos-Manhattan, Inc.
(industrial, automotive)
Raybestos-Manhattan, Inc.
Wabash Div.
(copper base, iron base, semi-metallic)
Wakefield Bearing Corp.
S. K. Wellman Co., The
(clutch facings, clutch plates, brake linings)

MAGNETIC MATERIALS

Hard—Alnico Type

Allegheny Ludlum Steel Corp.
Arnold Engineering Co., The
Ferroxcube Corp. of America
General Electric Co.
Magnetic Materials Sec.
General Electric Co.
Metallurgical Products Dept.
Indiana Steel Products Co., The
Kruse & Slattery, Inc.
Permag Corp.

Hard—Other Types

Aerovox Corp.
Crowley Div.
(barium ferrite)
Allegheny Ludlum Steel Corp.
Arnold Engineering Co., The
(Cunico)
Bunting Brass and Bronze Co.
(DC magnetic cores)
Ferroxcube Corp. of America
General Ceramics Corp.
(ceramic permanent magnets)
Indar Corp.
(Alnico, plastic bonded)
Indiana Steel Products Co., The
(Indox ceramic magnets)
National Moldite Co.
Stackpole Carbon Co.
(Ceramagnet permanent magnets)

Soft

Allegheny Ludlum Steel Corp.
American Powdered Metals, Inc.
Arnold Engineering Co., The
Asco Sintering Corp.
Bunting Brass and Bronze Co.

When it comes to metal powders selections . . . be sure to

specify HOEGANAES

. . . the complete line of metal powders that give you the properties you want—for the metal parts properties you want to produce

Here's *the* master check list of iron powders—highlighting the outstanding properties of Hoeganaes Iron Powders. If yours is a special problem, take a second look at this list . . . locate that grade best suited to your specifications. Then, call in the HSIC service specialist . . . he'll answer all detailed questions.

MH-100

Known throughout the powder metallurgy industry as the "work horse" of the industry. Famous as the world wide standard for uniformity, compressability, iron carbon parts production and copper infiltration.

MH-100-S
EP-1024

Equally famous for the properties above, plus improved compressability and purity. The "right" powder for production of large parts or higher density parts.

ANCOR 80

On down over the years, Ancor 80 is still the outstanding choice for green and sintered strength.

PRE-MIXES

You too, like so many parts fabricators, can eliminate your mix department worries. It's just this simple. Let HSIC produce and guarantee the proper composition for your requirements. HSIC now offers and supplies every conceivable iron base mix . . . including low alloy steel compositions for outstanding strength and other physical properties.

STAINLESS,

Inconel, Monel and other high alloy atomized powders.

Including low carbon, low silicon stainless, Hoeganaes now offers the most complete line of high alloy powders.

HSIC

HOEGANAES SPONGE IRON CORPORATION

RIVERTON, NEW JERSEY

SALES REPRESENTATIVES IN PRINCIPAL CITIES: Birmingham, Chicago, Cincinnati, Cleveland (Fostoria), Edmonton (Alberta, Canada), Los Angeles, Minneapolis, New England (Elmira, N.Y.), Philadelphia (Riverton, N. J.), Pittsburgh, San Francisco, St. Louis

For more information circle No. 43 on the Reader Service Card

Dixon Sintaloy, Inc.
Engineered Plastics, Inc.
American Sinterings Div.
Ferroxcube Corp. of America
General Ceramics Corp.
General Sintering Corp.
International Powder Metallurgy Co., Inc.
International Powder Metallurgy, Inc.
Rocky Mountain Metals Div., Inc.
Johnson Bronze Co.
Keystone Carbon Co.
Kwikset Powdered Metal Products
Merriman Bros., Inc.
Neosid (Canada) Ltd.
Presmet Corp., The

Iron Nickel

Allegheny Ludlum Steel Corp.
American Powdered Metals, Inc.
Arnold Engineering Co., The
Asco Sintering Corp.
Dixon Sintaloy, Inc.
Engineered Plastics, Inc.
American Sinterings Div.
Ferro Powdered Metals, Inc.
General Sintering Corp.
International Powder Metallurgy, Inc.
Rocky Mountain Metals Div., Inc.
Keystone Carbon Co.
Kwikset Powdered Metal Products
Moraine Products Div.
General Motors Corp.
National Moldite Co.
Powdercraft Corp.
Presmet Corp., The
Sintered Metals, Inc.
Stackpole Carbon Co.
Wakefield Bearing Corp.

Iron Silicon

Allegheny Ludlum Steel Corp.
American Powdered Metals, Inc.
Engineered Plastics, Inc.
American Sinterings Div.
Ferro Powdered Metals, Inc.
General Sintering Corp.
Keystone Carbon Co.
Kwikset Powdered Metal Products
National Moldite Co.
Presmet Corp., The
Sintered Metals, Inc.

Other Types

Allegheny Ludlum Steel Corp.
Asco Sintering Corp.
(pure iron)
Bunting Brass and Bronze Co.
(pure iron)
Ceromet, Inc.
(pure iron)
Chrysler Corp.
Amplex Div.
(pure iron)
Engineered Plastics, Inc.
American Sinterings Div.
(electrolytic iron)
General Ceramics Corp.
(ferrites)
Neosid (Canada) Ltd.
(microwave components)
Powdercraft Corp.
(pure iron)
Presmet Corp., The
(pure iron)
Stackpole Carbon Co.
(Ceramag–soft ferrites)

STRUCTURAL PARTS

Brass

American Powdered Metals, Inc.
American Sinteel Corp.
Sub. of The Mueller Brass Co.
Asco Sintering Corp.
Bound Brook Oil-less Bearing Co.
Chicago Powdered Metal Products Co.
Chrysler Corp.
Amplex Div.
Clevite Limited
Compacted Metals Corp.
Dixon Sintaloy, Inc.
Eberhart Steel Products
Powdered Metals Div.
Elco Sintered Alloys Co., Inc.
Engineered Plastics, Inc.
American Sinterings Div.
Ferro Powdered Metals, Inc.
General Sintering Corp.
Haller, Inc.
International Powder Metallurgy Co., Inc.
International Powder Metallurgy, Inc.
Rocky Mountain Metals Div., Inc.
Johnson Bronze Co.
Keystone Carbon Co.
Kwikset Powdered Metal Products
Lux Clock Mfg. Co., Inc.
Merriman Bros., Inc.

PYRON

THE IRON POWDER

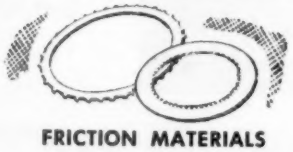
that makes the difference

IN

BEARINGS

STRUCTURAL PARTS

ELECTRONIC USES



FRICTION MATERIALS

ALSO IRON POWDERS FOR: ■ METALLURGICAL USES ■ WELDING ELECTRODES ■ SEED CLEANING ■ CUTTING WHEELS ■ PHARMACEUTICAL USES AND ALLOY AND IRON POWDERS TO SPECIFICATIONS

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Metal Powders

One source for both Laboratory and production Quantities of all available metal powders, Aluminum to Zirconium.

Distributors For:

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How Keystone QUALIFIES

as the leading independent producer of POWDER METAL PARTS

(over 150,000,000 of them annually)

We're told, often enough, that "There's a difference in dealing with Keystone."

In looking over some of the reasons-why, it occurs to us that because we were pioneers in powder metallurgy, perhaps we do have a special kind of perspective about our work. Over and beyond the essentials of a sound organization and production facilities to meet your requirements for almost any quantity of parts . . . on time, and at low cost . . . we have qualifications that are inseparable from the Keystone way of doing things.

One of them is *alert interest* in your problems (we learn more that way). Another: *creative approach* to your designs—which keeps us flexible. And one of special importance: *objective evaluation*—if application is unsound, we're frank to say so.

Perhaps we should conclude with *progressiveness*. Facts are, Keystone was first to produce commercially powder metal parts of alloy and stainless steels; first in the field to offer lower-than-commercial tolerance bearings, and first to provide corrosion-resistant finishes on iron powder parts.

For these and other reasons, a great many people turn to Keystone for the powder metal parts their businesses require. It's easily possible that you'd enjoy having us work for you, too. Write, and let's talk it over.

Keystone CARBON COMPANY

ST. MARYS, PA.

POWDERED METAL PARTS DIVISION

For more information circle No. 100 on the Reader Service Card

Metal Ceramics Powdered Metal Prod.
Metal Powder Products, Inc.
Mueller Brass Co.
National Molded Products, Inc.
Norwalk Powdered Metals, Inc.
Pacific Sintered Metals Co.
Parker White Metal Co.
Perth Metal Industries Ltd.
Powdercraft Corp.
Presmet Corp., The
Pure Carbon Co., Inc.
Reese Metal Products Corp.
St. Marys Carbon Co.
Sintered Metals, Inc.
Standard Automation Products
Standard Carbon Co.
Sterling Engineering Corp.
Superior Carbon Products, Inc.
United States Graphite Co., The
Div. of The Wickes Corp.
Wakefield Bearing Corp.
Western Sintering Co.

Copper Base

American Powdered Metals, Inc.
American Sinteel Corp.
Sub. of The Mueller Brass Co.
Arrow Sintered Products Co.
Asco Sintering Corp.
Bassick Co., The
Bound Brook Oil-less Bearing Co.
Brockway Pressed Metals, Inc.
Bunting Brass and Bronze Co.
Burgess-Norton Mfg. Co.
Carbon City Products Co., Inc.
Ceromet, Inc.
Chicago Powdered Metal Products Co.
Chrysler Corp.
Amplex Div.
Clevite Limited
Compacted Metals Corp.
Dixon Sintaloy, Inc.
Eberhart Steel Products
Powdered Metals Div.
Elco Sintered Alloys Co., Inc.
Engineered Plastics, Inc.
American Sinterings Div.
Ferro Powdered Metals, Inc.
Ford Motor Co.
General Sintering Corp.
Haller, Inc.
Indar Corp.
International Powder Metallurgy Co., Inc.
International Powder Metallurgy, Inc.
Rocky Mountain Metals Div., Inc.
Johnson Bronze Co.
Keystone Carbon Co.
Kruse & Slattery, Inc.
Kwikset Powdered Metal Products
Lux Clock Mfg. Co., Inc.
A. B. McMahan Co.
Merriman Bros., Inc.
Metal Ceramics Powdered Metal Prod.
Metal Powder Products, Inc.
Midwest Sintered Products Corp.
Moraine Products Div.
General Motors Corp.
Mueller Brass Co.
National Molded Products, Inc.
Norwalk Powdered Metals, Inc.
Pacific Sintered Metals Co.
Parker White Metal Co.
Perth Metal Industries Ltd.
Picco, Inc.
Powdercraft Corp.
Precision Metal Products Co.
Presmet Corp., The
Reese Metal Products Corp.
St. Marys Carbon Co.
Sintered Metals, Inc.
Standard Automation Products
Standard Carbon Co.
Sterling Engineering Corp.
Superior Carbon Products, Inc.
Symmco, Inc.
Technametals, Inc.
United States Graphite Co., The
Div. of The Wickes Corp.
Wakefield Bearing Corp.
Western Sintering Co.

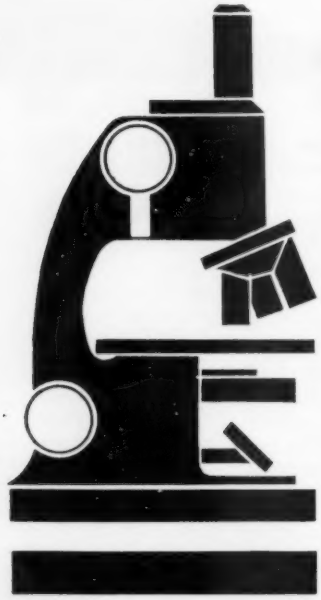
Filters

Arrow Sintered Products, Inc.
(bronze)
Asco Sintering Corp.
(bronze, monel, stainless steel, pure copper)
Bunting Brass and Bronze Co.
Metal Ceramics Powdered Metal Prod.
Micro Metallic Corp.
St. Marys Carbon Co.
Sintered Metals, Inc.

Iron Base, Controlled Porosity

Allied Products Corp.
Powdered Metal Parts Div.
American Powdered Metals, Inc.

For Increased Hardness & Rupture Strength in Powdered Metal Structural Parts . . . **USE SOUTHWESTERN MICROCRYSTAL* GRAPHITE**



FLOWS FREELY
MICROCRYSTAL Graphite flows freely, mixes uniformly with iron or iron alloy powders because it's all natural flake graphite and is less than two microns in average particle size.

REACTS QUICKLY
MICROCRYSTAL Graphite reacts quickly in sintering, and establishes an integrated carbon content, with resultant increased sintered end-product strength and hardness.

LABORATORY CONTROL
Strict laboratory control, from mine to finished product, assures continuous adherence to product specifications.

TEST SAMPLE
Send for a test sample (no charge) of MICROCRYSTAL Graphite today. It could be the means to improve your product in both tensile strength and hardness.

*Less than two micron average particle size.

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a product of
SOUTHWESTERN GRAPHITE COMPANY
Producers of Flake Graphite
GRAPHITE ROAD, BURNET, TEXAS.

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Johnson
Ledaloyl Powder Metallurgy

Bronze or Iron
Bearings . . . Bushings . . . Parts
Offer Many Important Savings

Pre-Lubrication—The porous structure of Johnson Ledaloyl acts as a reservoir for the lubricant, providing sufficient oil during operation . . . storing it when at rest. This feature often eliminates costly lubricating devices and systems, guards against neglect and assures longer operating life of the unit.

Formed to size—The manufacturing process of Johnson Ledaloyl is essentially a forming and sintering operation. This eliminates machining, prevents scrap, yet provides accuracy at a low unit cost. Uniformity of each bearing, or part, cuts assembly time to a minimum. These are but two of the many money-saving features of Johnson Ledaloyl bearings, bushings, and structural parts. Let us show you how to design your product to take full advantage of this economy yet gain greater performance and longer service life. No obligation of course. Write for literature today.

This literature free upon request.

Johnson Bronze

770 South Mill Street • New Castle, Pa.

Subsidiary: Apex Bronze Foundry Co., Oakland, California

JOHNSON Bearings

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for Production Ease

VASCO
PREALLOYED
METAL POWDERS

—and for the controlled physical qualities you demand in the finished part

The improved particle shape now achieved in Vasco Prealloyed Metal Powders results in better moldability and increased green strength . . . advances that join with the inherent superiority of *prealloyed* powder performance to create the most versatile, easy-to-use range of high-strength metal powder grades available today.

Each Vasco Prealloyed powder particle, produced from a molten stream of metal, is a tiny ingot of exactly the same chemical composition as the original melt. Your part made from such a powder is completely homogeneous—as much so, except for density, as a solid bar of the original analysis.

Select Vasco Prealloyed Metal Powders from many grades available, including chrome-nickel stainless, chromium stainless, low alloy structural, nickel and silicon-iron, hard facing alloys and brazing powders, nickel-copper and nickel-chromium iron alloys, special corrosion and heat resistant alloys and tool steels. Your orders are filled promptly from our mill warehouse. Write.

Vanadium-Alloys Steel Company

Powder Metallurgy Department

LATROBE, PENNSYLVANIA

For more information circle No. 91 on the Reader Service Card

American Sinteel Corp.
Sub. of The Mueller Brass Co.
Arrow Sintered Products Co.
Asco Sintering Corp.
Bassick Co., The
Bound Brook Oil-less Bearing Co.
Brockway Pressed Metals, Inc.
Bunting Brass and Bronze Co.
Burgess-Norton Mfg. Co.
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Powdered Metals Div.
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Indar Corp.
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International Powder Metallurgy, Inc.
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Johnson Bronze Co.
Keystone Carbon Co.
Kruse & Slattery, Inc.
Kwikset Powdered Metal Products
Link-Belt Co.
Lux Clock Mfg. Co., Inc.
Merriman Bros., Inc.
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Metal Powder Products, Inc.
Moraine Products Div.
General Motors Corp.
Mueller Brass Co.
National Moldite Co.
Norwalk Powdered Metals, Inc.
Pacific Sintered Metals Co.
Parker White Metal Co.
Perth Metal Industries Ltd.
Picco, Inc.
Powdercraft Corp.
Precision Metal Products Co.
Presmet Corp., The
Reese Metal Products Corp.
St. Marys Carbon Co.
Sintered Metals, Inc.
Standard Automation Products
Sterling Engineering Corp.
Superior Carbon Products, Inc.
Symmco, Inc.
Technametals, Inc.
United States Graphite Co., The
Div. of The Wickes Corp.
Wakefield Bearing Corp.
Western Sintering Co.
Iron Base, High Density, Copper Free
American Powdered Metals, Inc.
American Sinteel Corp.
Sub. of The Mueller Brass Co.
Arrow Sintered Products Co.

Asco Sintering Corp.
Bassick Co., The
Bound Brook Oil-less Bearing Co.
Brockway Pressed Metals, Inc.
Bunting Brass and Bronze Co.
Burgess-Norton Mfg. Co.
Carbon City Products Co., Inc.
Ceromet, Inc.
Chicago Powdered Metal Products Co.
Chrysler Corp.
Amplex Div.
Clevite Limited
Compacted Metals Corp.
Dixon Sintaloy, Inc.
Eaton Mfg. Co.
Powdered Metals Div.
Eberhart Steel Products
Powdered Metals Div.
Engineered Plastics, Inc.
American Sinterings Div.
Ferro Powdered Metals, Inc.
Ford Motor Co.
General Sintering Corp.
Globe Industries, Inc.
Supermet Div.
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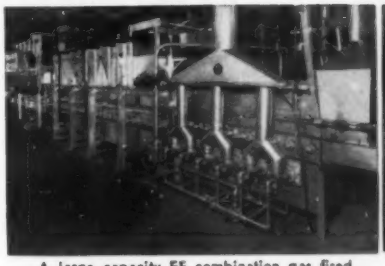
Indar Corp.
International Powder Metallurgy Co., Inc.
International Powder Metallurgy, Inc.
Rocky Mountain Metals Div., Inc.
Johnson Bronze Co.
Keystone Carbon Co.
Kruse & Slattery, Inc.
Kwikset Powdered Metal Products
P. R. Mallory & Co., Inc.
Merriman Bros., Inc.
Metal Ceramics Powdered Metal Prod.
Metal Powder Products, Inc.
Moraine Products Div.
General Motors Corp.
Mueller Brass Co.
National Moldite Co.
Norwalk Powdered Metals, Inc.
Pacific Sintered Metals Co.
Parker White Metal Co.
Perth Metal Industries Ltd.
Presmet Corp., The
Reese Metal Products Corp.
Sintered Metals, Inc.
Standard Automation Products
Standard Carbon Co.
Sterling Engineering Corp.
Superior Carbon Products, Inc.
Technametals, Inc.
United States Graphite Co., The
Div. of The Wickes Corp.
Wakefield Bearing Corp.
Western Sintering Co.

Iron Base, Infiltrated

Allied Products Corp.
Powdered Metal Parts Div.
American Powdered Metals, Inc.
American Sinteel Corp.
Sub. of The Mueller Brass Co.
Arrow Sintered Products Co.
Asco Sintering Corp.
Bassick Co., The
Bound Brook Oil-less Bearing Co.
Bunting Brass and Bronze Co.
Burgess-Norton Mfg. Co.

THE ELECTRIC FURNACE CO. Salem Ohio. EF Gas Fired, Oil Fired and Electric Furnaces.

EF FURNACES *for Sintering* Metal Powder Products



A large capacity EF combination gas fired radiant tube and electrically heated roller hearth type furnace for sintering metal powder parts at temperatures up to 2050°F.

A comparatively small EF hand operated pusher type electric furnace suitable for experimental work and small production runs on both ferrous and non-ferrous products.

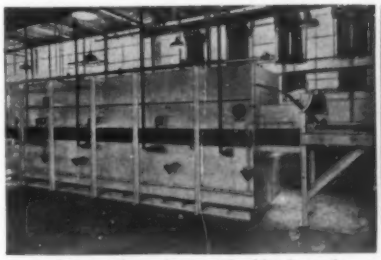
EF furnaces for processing ferrous and non-ferrous powder products assure:

- **lowest cost per pound for the sintering operation.**
- **maximum uniformity of size for the sintered products**
- **maximum pounds of quality product per dollar invested.**

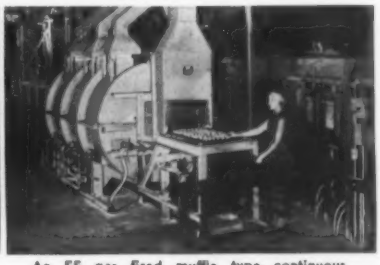
Long experience with special atmospheres, metal powders, bonding powder to strip and all heat processing phases connected with powder metallurgy has enabled EF engineers to develop and install equipment for producing some rather outstanding results.

With our extensive experience and complete manufacturing facilities we are in position to build the size and type equipment to best suit your specific requirements.

We would like to discuss some of our latest furnace developments with you, if interested.



Fusing metal powder to strip. Metal powder is being fused on six separate strands of strip, simultaneously and continuously, in this EF roller hearth type furnace.



An EF gas fired muffle type continuous furnace—another of the numerous types we build for sintering non-ferrous and iron powder products at various temperatures.

EF

BULLETIN No. 461
shows typical installations of EF Gas-fired, Oil-fired and Electric Furnaces.
Send for a copy today!

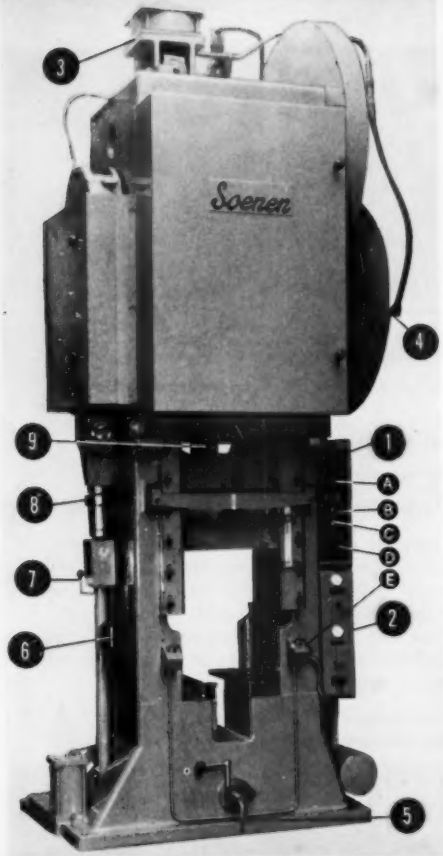
THE ELECTRIC FURNACE CO.
GAS FIRED, OIL FIRED AND ELECTRIC FURNACES FOR ANY PROCESS, PRODUCT OR PRODUCTION *Salem - Ohio*

Branch Offices in Detroit, Mich., Cheshire, Conn., and Santa Ana, Calif.
Canadian Associates • CANEFCO LIMITED • Toronto 13, Ontario

For more information circle No. 32 on the Reader Service Card

You are invited
to Booth 28
at the 1959 MPI Show
to see the latest

COMPACTING PRESSES using "Withdrawal Tooling"



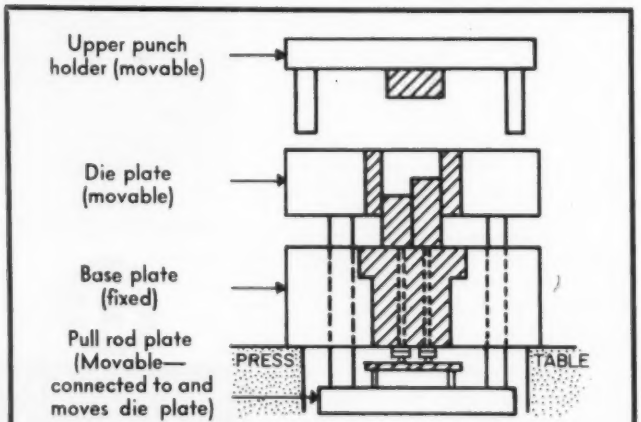
MODEL 200T-50	
CAPACITY	220 TONS
MOTOR H.P.	25
MAX. STROKES/MINUTE	20
MAX. DIE FILL	6 INCHES

A. Johnson & Company, Inc. offers modern presses in sizes between 6 and 1,100 tons. Some of their outstanding features are:

1. Allen-Bradley Electrical Controls (Nema 12 enclosure)
   a) single cycle-continuous cycle switch.
   b) automatic stop (T.D.C. position)
   c) emergency stop.
   d) forward-reverse motor control switch.
   e) quick acting inching control.
2. Separately housed pneumatic controls.
3. Quick acting pneumatic brake.
4. Synchronized pneumatic clutch.
5. Fill height adjustment crank.
6. Bejur central lubrication system.
7. Independent movement control for lower ram.
8. Turnbuckle sequencing die movement with upper punch.
9. Upper ram adjustment.

Other features not shown are: NEMA design "D" electric motor, shuttle type fill shoe and adjustable power drive, pneumatic spring or counter control of die, Sperry Products "Monitron" overload protection, Universal tool-set. Send for brochure describing complete details of presses and tooling.

Our "Withdrawal Tooling" design enables tooling to be installed in the set on the bench resulting in minimum set-up time and therefore, a reduction of the overall down time of the press. With the interchangeability of tools in the Universal tool-set TOOLING COSTS ARE COMPARABLE WITH EJECTION TYPE TOOLING.



Cross section in white outlines Universal tool-set. Shaded sections indicate changeable tools for specific parts.

MEMBER METAL POWDER mpi INDUSTRIES FEDERATION

A. JOHNSON & COMPANY, INC.

21 WEST STREET • NEW YORK 6, N. Y.

For more information circle No. 51 on the Reader Service Card

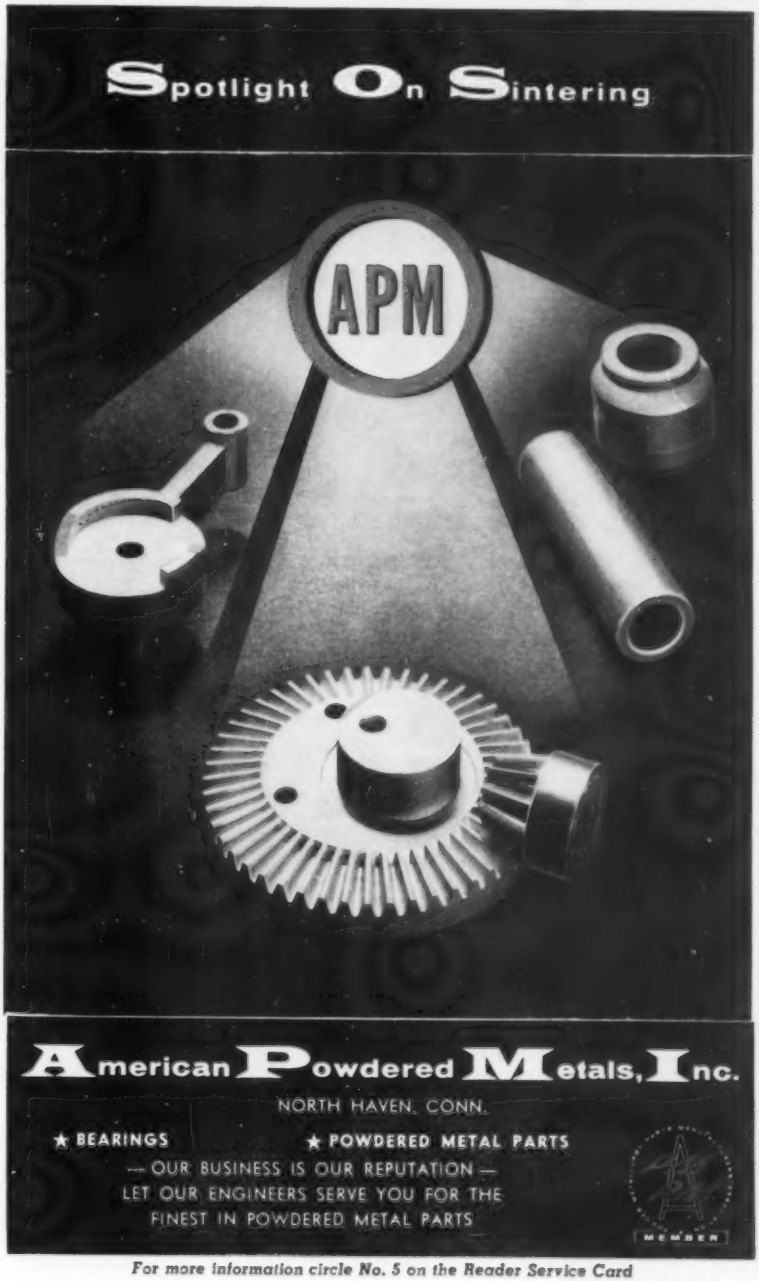
Ceromet, Inc.
Chicago Powdered Metal Products Co.
Chrysler Corp.
Amplex Div.
Clevite Limited
Compacted Metals Corp.
Dixon Sintaloy, Inc.
Eaton Mfg. Co.
Powdered Metals Div.
Eberhart Steel Products
Powdered Metals Div.
Elco Sintered Alloys Co., Inc.
Engineered Plastics, Inc.
American Sinterings Div.
Ferro Powdered Metals, Inc.
Ford Motor Co.
General Sintering Corp.
Haller, Inc.
Indar Corp.
International Powder Metallurgy Co., Inc.
International Powder Metallurgy, Inc.
Rocky Mountain Metals Div., Inc.
Johnson Bronze Co.
Kruse & Slattery, Inc.
Kwikset Powdered Metal Products
Lux Clock Mfg. Co., Inc.
Merriman Bros., Inc.
Metal Ceramics Powdered Metal Prod.
Metal Powder Products, Inc.
Moraine Products Div.
General Motors Corp.
Mueller Brass Co.
National Molded Products, Inc.
Norwalk Powdered Metals, Inc.
Pacific Sintered Metals Co.
Parker White Metal Co.
Perth Metal Industries Ltd.
Picco, Inc.
Powder Metal Products, Inc.
Powdercraft Corp.
Presmet Corp., The
Reese Metal Products Corp.
Sintered Metals, Inc.
Standard Automation Products
Sterling Engineering Corp.
Superior Carbon Products, Inc.
Technametals, Inc.
United States Graphite Co., The
Div. of The Wickes Corp.
Wakefield Bearing Corp.
Western Sintering Co.

Nickel Silver

American Powdered Metals, Inc.
American Sinteel Corp.
Sub. of The Mueller Brass Co.
Asco Sintering Corp.
Bassick Co., The
Bound Brook Oil-less Bearing Co.
Burgess-Norton Mfg. Co.
Chicago Powdered Metal Products Co.
Chrysler Corp.
Amplex Div.
Compacted Metals Corp.
Dixon Sintaloy, Inc.
Eberhart Steel Products
Powdered Metals Div.
Engineered Plastics, Inc.
American Sinterings Div.
Ferro Powdered Metals, Inc.
General Sintering Corp.
International Powder Metallurgy Co., Inc.
International Powder Metallurgy, Inc.
Rocky Mountain Metals Div., Inc.
Johnson Bronze Co.
Keystone Carbon Co.
Kwikset Powdered Metal Products
Lux Clock Mfg. Co., Inc.
Merriman Bros., Inc.
Metal Ceramics Powdered Metal Prod.
Metal Powder Products, Inc.
National Molded Products, Inc.
Norwalk Powdered Metals, Inc.
Pacific Sintered Metals Co.
Parker White Metal Co.
Perth Metal Industries Ltd.
Powdercraft Corp.
Presmet Corp., The
Reese Metal Products Corp.
St. Marys Carbon Co.
Sintered Metals, Inc.
Standard Automation Products
Sterling Engineering Corp.
Superior Carbon Products, Inc.
United States Graphite Co., The
Div. of The Wickes Corp.
Wakefield Bearing Corp.
Western Sintering Co.

Stainless Steel

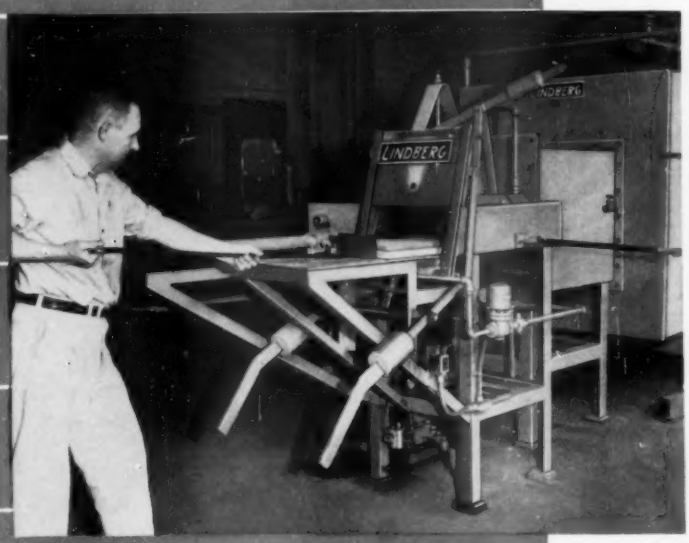
Asco Sintering Corp.
Engineered Plastics, Inc.
American Sinterings Div.



For more information circle No. 5 on the Reader Service Card

IF YOUR PRODUCTION NEEDS CALL
CAN CALL ON LINDBERG FOR JUST

Just as it does in all types of
Lindberg offers a full line of



A new Lindberg development, this Molybdenum Element Atmosphere Pusher Furnace is designed with high temperature refractories suitable for low dew point without need for a muffle. It is now being used for sintering stainless steel compacts in hydrogen or dissociated ammonia. Ammonia dissociator and control panels are shown at the right of the furnace below. In this installation hydrogen supply cylinders are located outside the building. Furnace provides side loading and discharge ports with purging chambers. Work trays, ceramic slabs or molybdenum boats, move through the furnace by hydraulic pusher. If you have a sintering or brazing problem why not talk it over with Lindberg.

Type MOP-12307-A8C Molybdenum Element Atmosphere Pusher Furnace. Maximum Temperature 3000° F. 60 KW input. 12" wide, 30" long, 7" high. 99" cooling chamber, 33" long preheat chamber.

Look Up Lindberg, Booth 2 At Metal Powder Show In Philadelphia.

LINDBERG heat for industry

FOR SINTERING YOU THE RIGHT FURNACE

industrial heating equipment; sintering and brazing furnaces

This Hand Pusher Batch Type Furnace

is used for small production lots and experimental sintering. It is an all-purpose unit for operation from 1300°F to 2500°F. Made in various sizes for sintering from 25 to 300 pounds per hour.

This Mesh Belt Continuous Type Furnace

is a popular sintering furnace for small light parts in copper, bronze, brass or steel with a temperature range from 1300°F. to 2100°F. It can be used for low temperature silver brazing, bright annealing, as well as sintering of powder metals. Production ranges up to 500 pounds per hour.

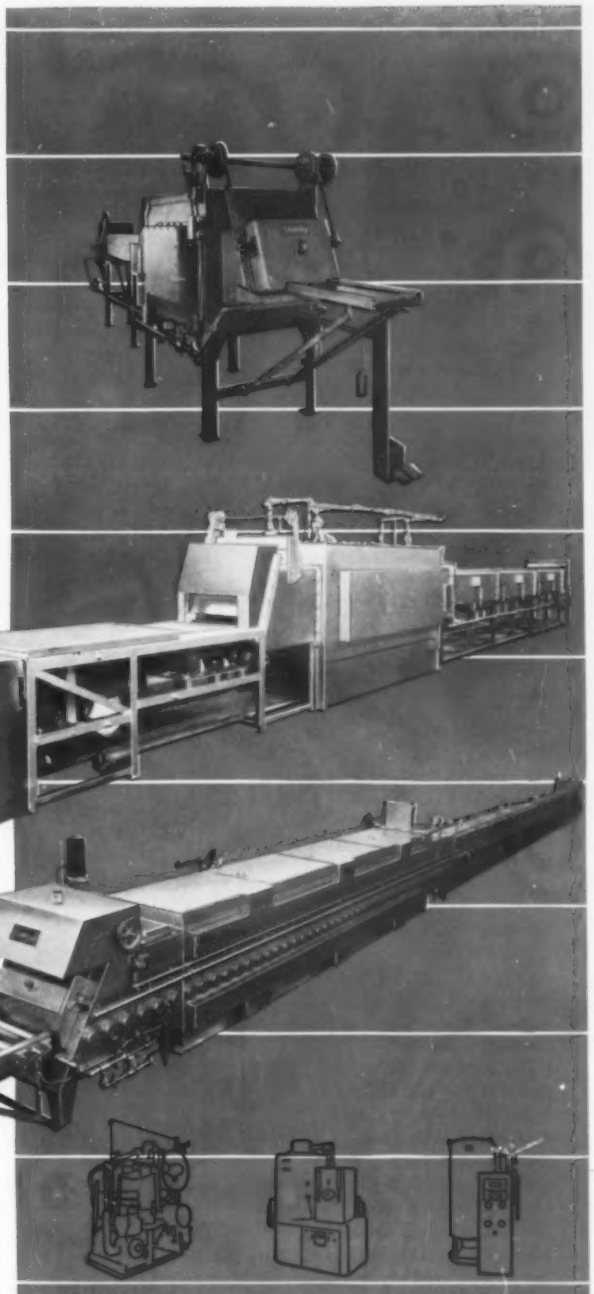
This Roller Hearth Continuous Type Furnace

is especially designed to handle heavier loads up to 2200 pounds per hour. It has an effective temperature range from 1300°F. to 2100°F. It can be used for bright annealing, low temperature silver brazing as well as sintering of powder metals.

Atmosphere Generators

To obtain the best work from any sintering furnaces, the proper atmosphere is required. The atmosphere generators described here provide the proper atmospheres recommended for use with Lindberg Sintering Furnaces.

If you have a sintering or brazing problem why not talk it over with Lindberg. Just get in touch with your nearest Lindberg Field Representative or write us direct.



1. The HYEX Generator produces atmosphere composed of approximately 4% carbon dioxide—18% hydrogen—12% carbon monoxide and 66% nitrogen.

2. The HYEN Generator produces a neutral atmosphere composed of approximately 21% carbon monoxide—40% hydrogen—38% nitrogen and 1% methane.

3. The HYAM Generator produces atmosphere composed of approximately 75% hydrogen and 25% nitrogen.

LINDBERG

ENGINEERING COMPANY

Los Angeles Plant: 11937 S. Regentview Ave., at Downey, Cal.

2463 W. HUBBARD ST., CHICAGO 12, ILL.

For more information circle No. 53 on the Reader Service Card

Globe Industries, Inc.
Supermet Div.
Keystone Carbon Co.
P. R. Mallory & Co., Inc.
Wakefield Bearing Corp.

Other Types

American Sinteel Corp.
Sub. of The Mueller Brass Co.
(infiltrated)
Asco Sintering Corp.
(special alloys)
Compacted Metals Corp.
(tungsten nickel)
General Sintering Corp.
(to customer specifications)
Kulite Tungsten Co.
(high density alloys, tungsten, molybdenum, cobalt)
P. R. Mallory & Co., Inc.
(high density tungsten alloys)
Powder Alloys Corp.
(tungsten base heavy metal)
Powder Metals Research, Inc.
(high density alloys, tungsten, molybdenum, cobalt)
Reese Metal Products Corp.
(nickel-copper)
Sintered Metals, Inc.
(gold, silver, platinum)

EQUIPMENT SUPPLIERS

DIES AND TOOLS

Cemented Carbide Dies

Allegheny Ludlum Steel Corp.
Carmet Div.
Champion Tool & Die Co.
Cleveland Tool & Die Co.
Arthur Colton Co.
Diecraft Tool Co.
Firth Sterling, Inc.
General Electric Co.
Metallurgical Products Dept.
A. Johnson & Co., Inc.
Kennametal, Inc.
Kulite Tungsten Co.
Major Gauge & Tool Co.
Micro-Carbide Tool & Die Co., Inc.
Monarch Tool & Gauge Co.
National Carbide Die Co.
Powder Metals Research, Inc.
Sintercast Corp. of America
John E. Skach Tool Co.
F. J. Stokes Corp.
Union Wire Die Corp.
Vascaloy-Ramet Corp.
Welded Carbide Tool Co., Inc.

Special core rods and punches

Cleveland Tool & Die Co.
(all types)
Arthur Colton Co.
(small press punches and dies)
Diecraft Tool Co.
(gear, cam and irregular)
A. Johnson & Co., Inc.
(withdrawal tooling)
Major Gauge & Tool Co.
Micro-Carbide Tool & Die Co., Inc.
(gear and cam cores and punch)
Monarch Tool & Gauge Co.
(cemented carbide gear punches and core rods)
National Carbide Die Co.
(carbide or steel)
Sintercast Corp. of America
John E. Skach Tool Co.
(carbide or steel)
F. J. Stokes Corp.
Vanadium-Alloys Steel Co.
(drill rod tool steels, die steels, high speed steels)

FURNACES, ELECTRIC

Abbot Corp.
Ajax Electrothermic Corp.
Continental-Industrial Engineers
Drever Co.
Electric Furnace Co., The
Falcon Equipment Co.
Ferguson Equipment Corp.
General Electric Co.
Apparatus Sales Div.
Haller, Inc.
Harper Electric Furnace Corp.
C. I. Hayes, Inc.
Hevi-Duty Electric Co.
Holcroft & Co.
Leeds & Northrup Co.
Lindberg Engineering Co.
Lithium Co., The
Mannesmann-Meer, Inc.
Pereny Equipment Co.
Posey Iron Works, Inc.
Industrial Heating Div.
Sargeant & Wilbur, Inc.
Sentry Co., The
F. J. Stokes Corp.
(vacuum)
Sunbeam Corp.
Industrial Furnace Div.
Sunbeam Equipment Corp.
Westinghouse Electric Corp.
Industrial Heating Div.

FURNACES, FUEL FIRED

Abbot Corp.
Continental-Industrial Engineers
Drever Co.
Electric Furnace Co., The
Ferguson Equipment Corp.
Gas Machinery Co., The
General Electric Co.
Apparatus Sales Div.
Haller, Inc.
Hevi-Duty Electric Co.
Holcroft & Co.
Leeds & Northrup Co.
Lindberg Engineering Co.
Lithium Co., The
A. B. McMahan Co.
Posey Iron Works, Inc.
Industrial Heating Div.
Sargeant & Wilbur, Inc.
Sunbeam Corp.
Industrial Furnace Div.
Sunbeam Equipment Corp.
Surface Combustion Corp.

GAS GENERATORS FOR CONTROLLED ATMOSPHERE

Anhydrous Ammonia

American Oil & Supply Co.
Armour & Co.
Armour Ammonia Div.
Henry Bower Chemical Mfg. Co.
Columbia-Southern Chemical Corp.
Grand River Chemical Co.
Hamler Industries, Inc.
Hercules Powder Co., Inc.
Kingston Chemical Co., Inc.
Monsanto Chemical Co.
Inorganic Chemicals Div.
Olin Mathieson Chemical Corp.
Chemicals Div.
Riverside Chemical Co., Inc.
Spencer Chemical Co.
U. S. Industrial Chemicals Co.
Wittichen Chemical Co.

Completely Combusted (Exo-Thermic) Gas

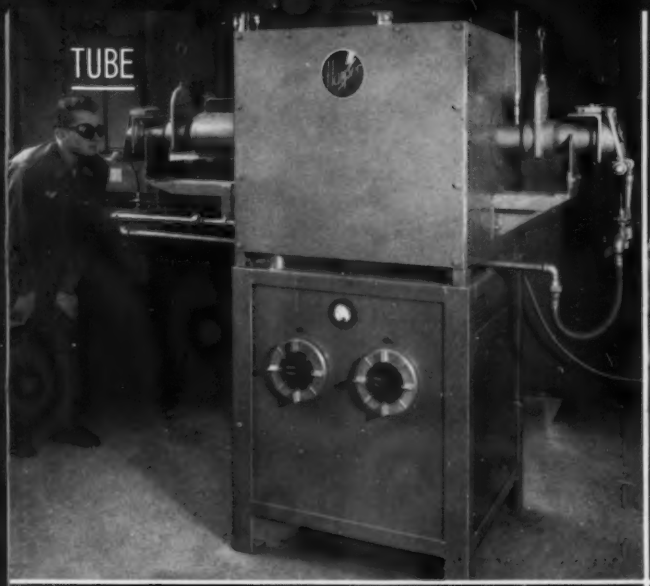
Continental-Industrial Engineers
Drever Co.
Electric Furnace Co., The
Ferguson Equipment Corp.
Gas Machinery Co., The
General Electric Co.
Apparatus Sales Div.
Haller, Inc.
C. I. Hayes, Inc.
Hevi-Duty Electric Co.
Holcroft & Co.
C. M. Kemp Mfg. Co., The
Lindberg Engineering Co.
Lithium Co., The
Sargeant & Wilbur, Inc.
Sunbeam Corp.
Industrial Furnace Div.
Sunbeam Equipment Corp.
Surface Combustion Corp.

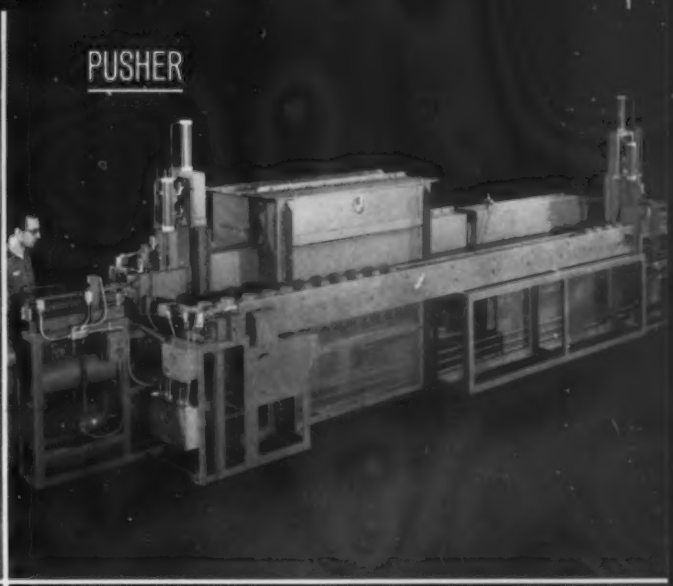
Partially Combusted (Endo-Thermic) Gas

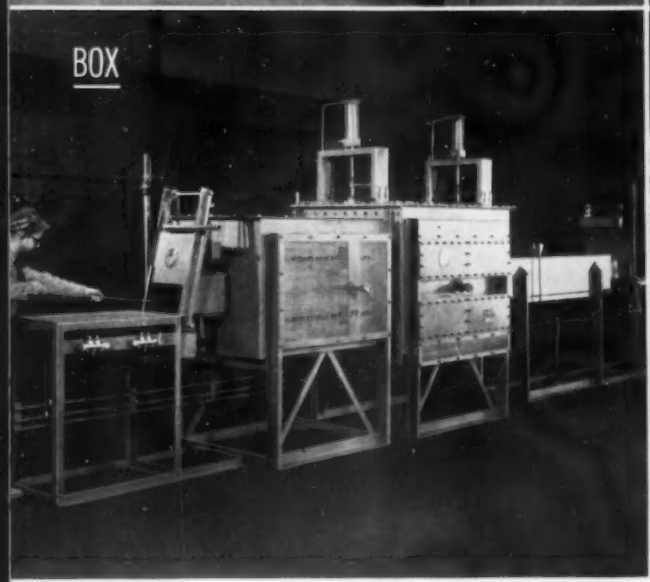
Continental-Industrial Engineers
Electric Furnace Co., The
Ferguson Equipment Corp.
Gas Machinery Co., The
General Electric Co.
Apparatus Sales Div.
Haller, Inc.
C. I. Hayes, Inc.
Hevi-Duty Electric Co.
Holcroft & Co.
Lindberg Engineering Co.
Lithium Co., The
Sargeant & Wilbur, Inc.
Sunbeam Corp.
Industrial Furnace Div.
Sunbeam Equipment Corp.
Surface Combustion Corp.

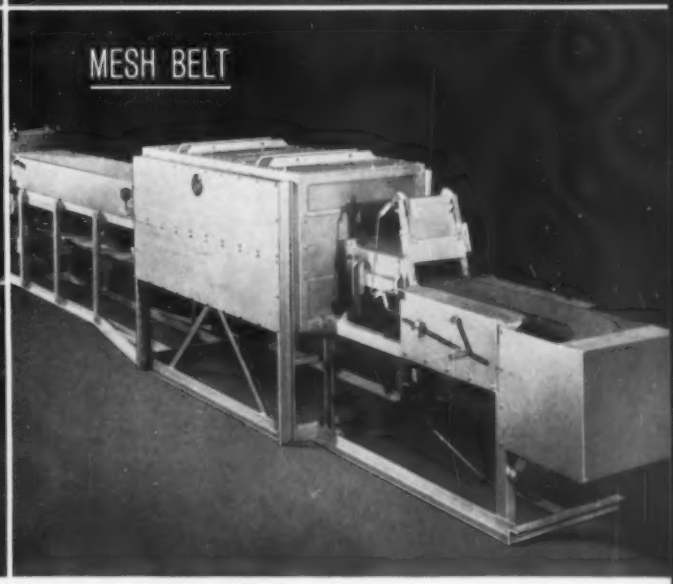
Dissociated Ammonia

Continental-Industrial Engineers









SINTERING FURNACES

all types to answer your powder metallurgy needs to best advantage

HARPER BUILDS THEM ALL: Box, pusher, mesh belt, roller hearth, bell, elevator and pit . . . for research, pilot plant and full scale production.

JUST NAME IT! No matter what the powdered metal — copper, brass, bronze, iron, iron graphite, tungsten or one of the stainless steels — Harper can supply the furnace that will do the sintering job most profitably for you. Furnished for manual and automatic operation, Harper electric furnaces are equipped with molybdenum, silicon carbide and nickel chromium alloy heating elements, as well as the proper refractories and controls, to match a diversified range of temperature and atmosphere requirements.

TAKE ADVANTAGE OF HARPER EXPERIENCE: The next time you are considering the addition or replacement of a sintering furnace, you'll find it pays to put it up to Harper early in the game — for Harper has the background to assist you in your planning. In the meantime, for more detailed information, write: Harper Electric Furnace Corp., 41 River St., Buffalo 2, N. Y.

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FOR BRAZING, SINTERING, WIRE ANNEALING, BRIGHT ANNEALING, FORGING AND RESEARCH

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Yours.. for the asking

The proper material for sintered bronze or iron bearings has always been a major problem to design men. Now for the first time a chart has been engineered, clearly showing the complete chemical, mechanical, and work characteristics of a wide range of sintered bearing materials. The best material for most applications can be selected by a draftsman in a matter of minutes. Only requests on company stationary will be honored.

BOUND BROOK

BOUND BROOK OIL-LESS BEARING CO., EST. 1883, BOUND BROOK, N. J.

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General Electric Co.
Apparatus Sales Div.
C. I. Hayes, Inc.
Hevi-Duty Electric Co.
Lindberg Engineering Co.
Lithium Co., The
Sargeant & Wilbur, Inc.
Sunbeam Corp.
Industrial Furnace Div.
Sunbeam Equipment Corp.
Surface Combustion Corp.

Liquid Hydrocarbon Decomposition

Continental-Industrial Engineers
Electric Furnace Co., The
General Electric Co.
Apparatus Sales Div.
C. I. Hayes, Inc.
Lithium Co., The
Sunbeam Corp.
Industrial Furnace Div.
Sunbeam Equipment Corp.

IMPREGNATION EQUIPMENT FOR SEALING POROUS PARTS

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(polyester, sodium silicate, oils, etc.)
Curd Enterprizes,
Multiplastics Div.
(Vacuum and pressure)
Imprex, Inc.
(vacuum, plastic and metallic)
Polyplastex Impregnation Corp.
(custom impregnator)
F. J. Stokes Corp.
(complete high vacuum systems)

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Federal Classifier Systems, Inc.
Haller, Inc.
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Loomis Engineering & Mfg. Co.
(laboratory presses)

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American Cyanamid Co.
Capital City Products Co., The
(Sterotex)
Leffingwell Chemical Co.
National Diamond Lab.
Nopco Chemical Co.
(stearates, synthetic high melting waxes)
M. W. Parsons-Plymouth, Inc.
(zinc stearate, calcium stearate, lithium stearate, barium stearate)
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Warwick Chemical Co. Div.
Whittaker, Clark & Daniels, Inc.
Witco Chemical Co.

Circle No. 16 on Reader Service Card

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Anglo American Mill Corp.
R. N. Bailey & Co., Inc.
Baker Perkins, Inc.
Capitol Products Corp.
Read Standard Div.
Cleveland Mixer Co., The
Arthur Colton Co.
J. H. Day Co. Div., The
Cleveland Automatic Machine Co.
Haller, Inc.
Mannesmann-Meer, Inc.
(impeller type)
A. B. McMahan Co.
Mercer-Robinson Co., Inc.
National Engineering Co.
Simpson Mix Muller Div.
Sturtevant Mill Co.
(revolving drum)
Taunton Engineering Works

PRESSES, HYDRAULIC

For forming green compacts.

American Brake Shoe Co.
Denison Engineering Div.
American Steel Foundries
Elmes Engineering Div.
Baldwin-Lima-Hamilton Corp.
Hamilton Div.
Baldwin-Lima-Hamilton Corp.
Loewy Hydropress Div.
E. W. Bliss Co.
Clifton Hydraulic Press Co.
Haller, Inc.
International Sales Management Co.
A. Johnson & Co., Inc.
Kux Machine Co.
Lake Erie Machinery Corp.
Logan Engineering Co.
Loomis Engineering & Mfg. Co.
(laboratory)
M & N Hydraulic Press Co., Inc.
Mannesmann-Meer, Inc.
Oliver Corp., The
A. B. Farquhar Div.
Standard Machinery Co.
F. J Stokes Corp.

For coining sintered compacts.

American Steel Foundries
Elmes Engineering Div.
E. W. Bliss Co.
Clifton Hydraulic Press Co.
Haller, Inc.
Hannifin Co.
A Div. of Parker-Hannifin Corp.
International Sales Management Co.
Kux Machine Co.
M & N Hydraulic Press Co., Inc.
Mannesmann-Meer, Inc.
Oliver Corp., The
A. B. Farquhar Div.
Standard Machinery Co.
F. J. Stokes Corp.

PRESSES, MECHANICAL

For forming green compacts

Arnhold Ceramics, Inc.
Baldwin-Lima-Hamilton Corp.
Hamilton Div.
E. W. Bliss Co.
Arthur Colton Co.
Haller, Inc.
A. Johnson & Co., Inc.
Johnson Machine & Press Corp.
Kux Machine Co.
Mannesmann-Meer, Inc.
Mansol Ceramic Co.
A. B. McMahan Co.
Minster Machine Co., The
Oliver Corp., The
A. B. Farquhar Div.
F. J. Stokes Corp.
Walsh Press & Die Co.
Div. of American Gage & Machine Co.

For coining sintered compacts.

E. W. Bliss Co.
Haller, Inc.
A. Johnson & Co., Inc.
Johnson Machine & Press Corp.
Kux Machine Co.
Mannesmann-Meer, Inc.
Minster Machine Co., The
Oliver Corp., The
A. B. Farquhar Div.
F. J. Stokes Corp.
Walsh Press & Die Co.
Div. of American Gage & Machine Co.

PYROMETERS & PYROMETRIC EQUIPMENT

Compensating Lead Wire

Barber-Colman Co.
Wheelco Instruments Div.
R. A. Ekstrom Co.
General Electric Co.
Apparatus Sales Div.
Claud S. Gordon Co.
Illinois Testing Laboratories, Inc.
Leeds & Northrup Co.
Minneapolis-Honeywell Regulator Co.
Brown Instruments Div.
Pyrometer Instrument Co.
Arklay S. Richards Co., Inc.
Service Associated, Inc.
West Instrument Corp.

Fuel Failure Protective Devices For Fuel Fired Furnaces

Barber-Colman Co.
Wheelco Instruments Div.
General Electric Co.
Apparatus Sales Div.
Illinois Testing Laboratories, Inc.
Minneapolis-Honeywell Regulator Co.
Brown Instruments Div.

PLAST-IRON POWDERS

REPLACE WITH

B-280

Standard 80 Mesh Iron Powder

IMPROVE WITH

B-281

Phos Enriched
80 Mesh Iron Powder

ECONOMIZE WITH

B-270

35 Mesh Reduced Iron Powder

PM 9d

Send for Technical Data and Working Sample

PM PLASTIC METALS

PLASTIC METALS

Division

National-U.S. Radiator Corporation

3459 BRIDGE STREET

JOHNSTOWN, PA.

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R. A. Ekstrom Co.
General Electric Co.
Apparatus Sales Div.
Illinois Testing Laboratories, Inc.
Minneapolis-Honeywell Regulator Co.
Brown Instruments Div.
Pyrometer Instrument Co., Inc.
Simpson Electric Co.
West Instrument Corp.

Optical Pyrometers

Claud S. Gordon Co.
Leeds & Northrup Co.
Pyrometer Instrument Co.

Potentiometer Type

Barber-Colman Co.
Wheelco Instruments Div.
General Electric Co.
Apparatus Sales Div.
Leeds & Northrup Co.
Minneapolis-Honeywell Regulator Co.
Brown Instruments Div.
Pyrometer Instrument Co.
West Instrument Corp.
Winslow Co., Inc., The

Program Controllers

Barber-Colman Co.
Wheelco Instruments Div.
General Electric Co.
Apparatus Sales Div.
Leeds & Northrup Co.
Minneapolis-Honeywell Regulator Co.
Brown Instruments Div.
West Instrument Corp.

Thermocouples

Barber-Colman Co.
Wheelco Instruments Div.
(all kinds)
R. A. Ekstrom Co.
General Electric Co.
Apparatus Sales Div.
Claud S. Gordon Co.
Illinois Testing Laboratories, Inc.
Kennametal, Inc.
(titanium carbide)
Leeds & Northrup Co.
Minneapolis-Honeywell Regulator Co.
Brown Instruments Div.
Pyrometer Instrument Co.
Arklay S. Richards Co., Inc.
Service Associated, Inc.
(all calibrations and styles of construction)
Simpson Electric Co.
West Instrument Corp.
Winslow Co., Inc., The
(bayonet)

Thermocouple Failure Protective Devices

Barber-Colman Co.
Wheelco Instruments Div.
General Electric Co.
Apparatus Sales Div.

Remet Powdered Metal Part cuts DESIGN and MACHINING costs for Bonney Forge and Tool Works

R. L. Huston, Chief Engineer for Bonney, says, "We went to a powdered metal part on our shifter because the cost of machining this part from steel would have been prohibitive. Also, we would have had to change the entire design of our ratchet. We contacted no less than a dozen fabricators of powdered metal. Reese Metal Products Corp. was the only establishment able or interested in tackling this problem with us."

Bonney now uses Remet shifters in seven of their ratchets. The sintered Remet parts are copper infiltrated iron.

More and more design and production men each year rely on Remet services to help solve problems.

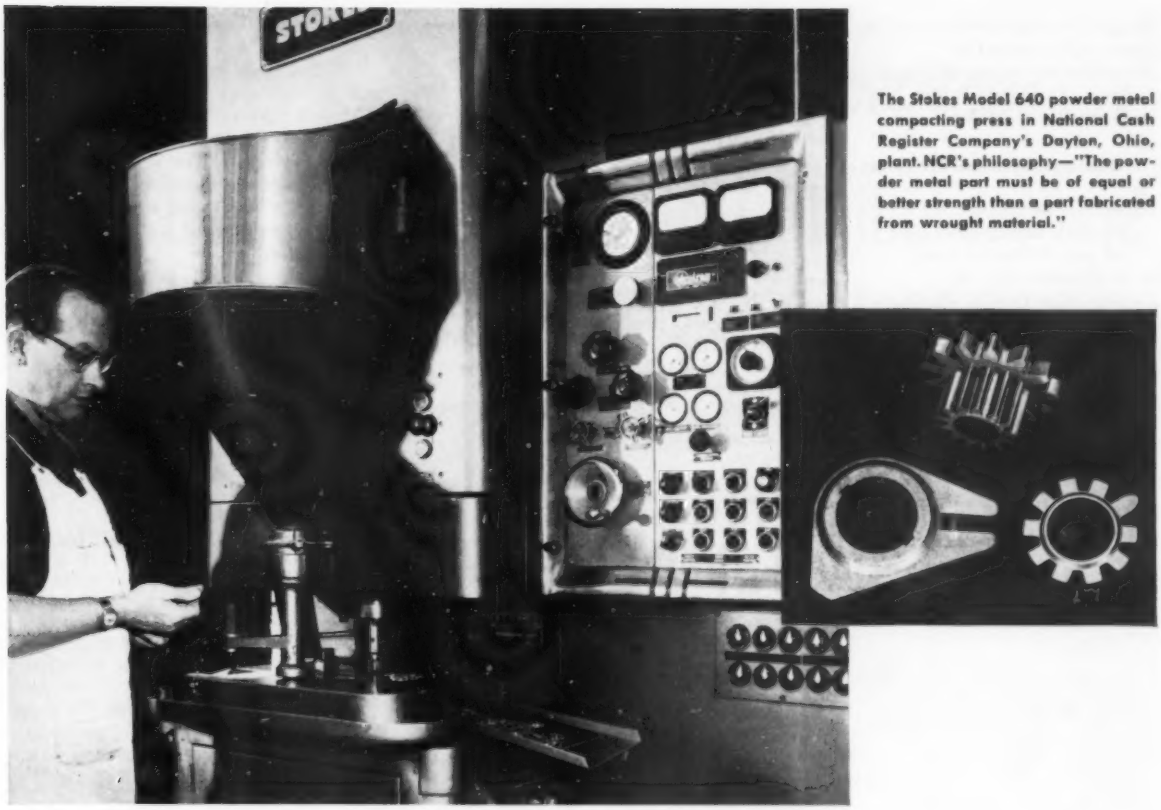
***FREE BROCHURE** "How to Cut Precision Parts Cost with the Remet Powdered Metal Process" shows how the Reese Corp. can help you. Send for your copy today.*

Remet

REESE METAL PRODUCTS CORPORATION

537 Howard Ave., Lancaster 10, Penna.

Gears • Pinions • Cams • Ratchets
"Oilless" Bearings • Bushings • Machine and Structural Parts in
COPPER • BRASS • IRON • ALLOY STEEL • NICKEL SILVER • COPPER INFILTRATED IRON



The Stokes Model 640 powder metal compacting press in National Cash Register Company's Dayton, Ohio, plant. NCR's philosophy—"The powder metal part must be of equal or better strength than a part fabricated from wrought material."

National Cash Register rings up savings through powder metallurgy...

The Stokes Model 640 50-ton powder metal press, at the Dayton, Ohio, plant of National Cash Register Company, has proved a valuable tool in the production of precision gears and parts for cash registers and accounting machines. In 1957, over 250 different high-density parts were made by powder metallurgy—in early '58, 47 additional parts went into production.

The economic benefits of this process have also been proved. A cost analysis of 54 parts shows substantial savings per year through lower direct labor costs in machining and inspection. More complex parts are continually being introduced—parts with hubs, steps, and thin projections—made possible by press equipment such as the Stokes 640.

The Stokes Model 640 offers up to five press motions with independently adjustable compression, fill and ejection points . . . each with direct reading position indicators calibrated to .001". This set-up versatility is teamed with operating simplicity that enables economical long or short runs, and permits easy re-runs of jobs on which set-up standards have been established.

Investigate the proved potential of powder metal pressing . . . not only for ways to cut costs and save metal over conventional machining, but also for ways to get properties of metals, alloys and mixtures not attainable by other techniques. Ask for a production and economic analysis on your own parts. Stokes' facilities include sample production, punch and die design and fabrication, and operator instruction. Stokes Engineering Advisory Service is ready to serve your powder metallurgy needs, whether large or small.

Powder Metal Press Division
F. J. STOKES CORPORATION
5500 Tabor Road, Philadelphia 20, Pa.

STOKES

For more information circle No. 86 on the Reader Service Card

Illinois Testing Laboratories, Inc.
Leeds & Northrup Co.
Minneapolis-Honeywell Regulator Co.
Brown Instruments Div.
West Instrument Corp.

Thermocouple Protective Tubes

Barber-Colman Co.
Wheelco Instruments Div.
(all conventional types)
R. A. Ekstrom Co.
General Electric Co.
Apparatus Sales Div.
Claud S. Gordon Co.
Illinois Testing Laboratories, Inc.
Leeds & Northrup Co.
Minneapolis-Honeywell Regulator Co.
Brown Instruments Div.
Morganite, Inc.
Arklay S. Richards Co., Inc.
Service Associated, Inc.
(metal, ceramic, quartz, carborundum)
West Instrument Corp.

SCREENING EQUIPMENT

R. N. Bailey & Co., Inc.
Arthur Colton Co.
J. H. Day Co. Div., The
Cleveland Automatic Machine Co., The
Exolon Co., The
B. F. Gump Co.
(rotary motion)
A. B. McMahan Co.
Mercer-Robinson Co., Inc.
F. J. Stokes Corp.
W. S. Tyler Co., The
(industrial – electrically and mechanically vibrated screens; laboratory-Sieves and Sieve shakers)

The New Home Of Quality Metal Powders

ALUMINUM
BRASS, LEADED BRASS
COPPER POWDER - GRAIN and FLAKE
NICKEL SILVER
INFILTRATING POWDERS

Composition and mesh to meet specific requirements. Selection range offering powders to match the part.

U. S. Bronze Powder Works, Inc.

FLEMINGTON, N. J.
Phone: FLemington 990

For more information circle No. 89 on the Reader Service Card

POWDER SUPPLIERS

ALUMINUM

Atlantic Powdered Metals, Inc.
Belmont Smelting & Refining Works, Inc.
Metals Disintegrating Co., Inc.
Reade Mfg. Co., Inc.
Reynolds Metals Co.
U. S. Bronze Powder Works, Inc.

BRASS

80-20

Belmont Smelting & Refining Works, Inc.
Glidden Co., The
Chemicals-Pigments-Metals Div.
Charles Hardy, Inc.
Metal Atomizing & Processing Corp. Ltd.
New Jersey Zinc Co., The
Powder Metallurgy Ltd.
U. S. Bronze Powder Works, Inc.

70-30

Atlantic Powdered Metals, Inc.
Belmont Smelting & Refining Works, Inc.
Glidden Co., The
Chemicals-Pigments-Metals Div.
Charles Hardy, Inc.
Metal Atomizing & Processing Corp. Ltd.
New Jersey Zinc Co., The
Powder Metallurgy Ltd.
U. S. Bronze Powder Works, Inc.

60-40

Belmont Smelting & Refining Works, Inc.
Glidden Co., The
Chemicals-Pigments-Metals Div.
Charles Hardy, Inc.
Metal Atomizing & Processing Corp. Ltd.
New Jersey Zinc Co., The
Powder Metallurgy Ltd.
U. S. Bronze Powder Works, Inc.

BRASS

Others

Atlantic Powdered Metals, Inc.
(flake brass)
Metal Powder & Chemical Wks., Inc.
(flake brass powders)
Metals Disintegrating Co., Inc.
(atomized brass)
U. S. Bronze Powder Works, Inc.
(iron bearings brass, leaded brass)

DENISON *Announces...*

a new hydraulic COMPACTING Multipress line in capacities from 2 to 75 tons

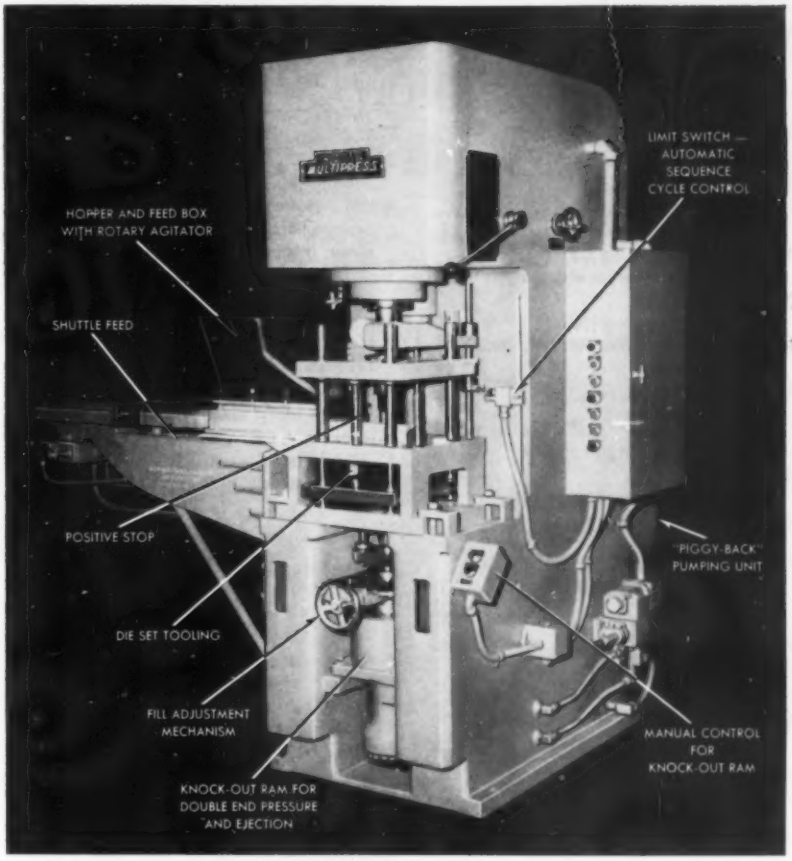
ELIMINATES SCRAP LOSS
Hydraulic ram pressure and speed controls are adjustable *up and down.* Timing prevents fracture of parts (due to vacuum) at time of ejection.

UNIFORM FILL AND DENSITY produce duplicate, uniform quality from part-to-part . . . even for thin, ring-type parts. Production is done to *extremely close tolerances.* Three exclusive features help make this possible: Ram pressure reversal, retractable core pin and two types of feeders available . . . rotary agitator or vibratory grid.

BUILT-IN SAFETY—Adjustable limit-switch settings and positive stop regulation guard the sequence operational cycle of the 3 hydraulic rams. Overloading the die is prevented—resulting in *longer die life* with less breakage.

UNIFORM CROSS-SECTIONAL DENSITY of compacted parts is assured by application of double-end pressure. And, where necessary to improve density, exclusive *Vibratory Ram Action* can also be applied.

ADJUSTABLE FILL FEATURE allows adjustment of the volume capacity of the die even while the press is in operation. Result is fast, simple setup changes—and ability to *compensate for variations in material* (particle size, moisture content, etc.) from batch to batch.


MULTIPRESS
LIMIT SWITCH — AUTOMATIC SEQUENCE CYCLE CONTROL
HOPPER AND FEED BOX WITH ROTARY AGITATOR
SHUTTLE FEED
POSITIVE STOP
"PIGGY-BACK" PUMPING UNIT
DIE SET TOOLING
FILL ADJUSTMENT MECHANISM
MANUAL CONTROL FOR KNOCK-OUT RAM
KNOCK-OUT RAM FOR DOUBLE END PRESSURE AND EJECTION

New Hydraulic Compacting Presses . . . from Denison feature exclusive shuttle-feed with rotary agitator for compacting—powdered metal, plastics, "teflon", ceramics, food products, chemicals, pharmaceuticals, carbon, asbestos, ground cork, powdered glass, plastic-impregnated fibrous material, uranium oxide, fertilizer, abrasives. Denison Multipress offers fabricators many unique quality-control, cost-saving production advantages.

Write for full details in Bulletin M-11-B

HYDRAULIC PRESSES
PUMPS • MOTORS • CONTROLS

DENISON HydrOILics

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American Brake Shoe Co.
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Denison Stocking Branch Offices:
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For more information circle No. 31 on the Reader Service Card

COPPER

Atomized

Atlantic Powdered Metals, Inc.
Glidden Co., The
Chemicals-Pigments-Metals Div.
Greenback Industries, Inc.
Malone Metal Powders, Inc.
Metal Atomizing & Processing Corp. Ltd.
New Jersey Zinc Co., The
U. S. Bronze Powder Works, Inc.

Electrolytic

American Metal Climax, Inc.
Belmont Smelting & Refining Works, Inc.
Malone Metal Powders, Inc.
U. S. Bronze Powder Works, Inc.

Other Types

Atlantic Powdered Metals, Inc.
(flake copper)
Charles Hardy, Inc.
(chemically prec.)
Malone Metal Powders, Inc.
Metal Powder & Chemical Wks., Inc.
(flake copper powders)
Metals Disintegrating Co., Inc.
(reduced oxide from electrolytic)
National Lead Co.
(chemically precipitated)
U. S. Bronze Powder Works, Inc.
(flake copper)
Whitaker Metals Corp.
(precipitated)

Sponge

Glidden Co., The
Chemicals-Pigments-Metals Div.
Greenback Industries, Inc.

IRON

Atomized

Easton Metal Powder Co., Inc.
Ferrum Limited
Foote Mineral Co.
Hoeganaes Sponge Iron Corp.
Vanadium-Alloys Steel Co.

Carbonyl

Antara Chemicals
Div. of General Aniline & Film Corp.
Belmont Smelting & Refining Works, Inc.
Charles Hardy, Inc.
National Moldite Co.

Decarburized Cast Iron

Vanadium-Alloys Steel Co.

Electrolytic

Foote Mineral Co.
Charles Hardy, Inc.
A. Johnson & Co., Inc.
National-U.S. Radiator Corp.
Plastic Metals Div.

Hydrogen Reduced

Alan Wood Steel Co.
Belmont Smelting & Refining Works, Inc.
Charles Hardy, Inc.
Hoeganaes Sponge Iron Corp.
Magnetic Powders, Inc.
National Moldite Co.
Pyron Corp.
Republic Steel Corp.
Metal Powder Div.
C. K. Williams & Co.

Sponge

Belmont Smelting & Refining Works, Inc.
Ferrum Limited
Charles Hardy, Inc.
Hoeganaes Sponge Iron Corp.
Metal Powders, Ltd.
Micronized Metals, Inc.
National Moldite Co.
National-U.S. Radiator Corp.
Plastic Metals Div.

Others

Belmont Smelting & Refining Works, Inc.
(cast iron powder)
Magnetic Powders, Inc.
(hydrogen annealed)
Metal Powders, Ltd.
(copper nickel iron, molybdenum nickel iron, sponge iron — annealed)
Metals Disintegrating Co., Inc.
(milled flake iron, iron oxide)
Republic Steel Corp.
Metal Powder Div.
(Pre-blends with Cu, Cu & C, or C)
Vanadium-Alloys Steel Co.
(silicon irons, aluminum irons, nickel irons)
C. K. Williams & Co.
(iron oxides for magnetic ferrites)

LEAD

Belmont Smelting & Refining Works, Inc.
Glidden Co., The
Chemicals-Pigments-Metals Div.
Metals Disintegrating Co., Inc.
Powder Metallurgy Ltd.
National Lead Co.

NICKEL

Belmont Smelting & Refining Works, Inc.
Foote Mineral Co.
International Nickel Co., Inc., The
Metal Atomizing & Processing Corp. Ltd.
Metals Disintegrating Co., Inc.
Micronized Metals, Inc.
National Lead Co.
National-U.S. Radiator Corp.
Plastic Metals Div.
Pyron Corp.
Sherritt Gordon Mines Ltd.
Vanadium-Alloys Steel Co.

NICKEL SILVER

Belmont Smelting & Refining Works, Inc.
Charles Hardy, Inc.
Metal Atomizing & Processing Corp. Ltd.
Metals Disintegrating Co., Inc.
New Jersey Zinc Co., The
Powder Metallurgy Ltd.
Reade Mfg. Co., Inc.

STEEL

High Alloy

Charles Hardy, Inc.
Hoeganaes Sponge Iron Corp.
Metal Atomizing & Processing Corp. Ltd.
Uniworld Research Corp. of America
Vanadium-Alloys Steel Co.

Low Alloy

Charles Hardy, Inc.
Hoeganaes Sponge Iron Corp.
Pyron Corp.
Republic Steel Corp.
Metal Powder Div.
Vanadium-Alloys Steel Co.

Plain Carbon

Charles Hardy, Inc.
Metal Powders, Ltd.
Vanadium-Alloys Steel Co.

Stainless

Alloy Metal Powders, Inc.
Charles Hardy, Inc.
Hoeganaes Sponge Iron Corp.
Metal Atomizing & Processing Corp. Ltd.
Metals Disintegrating Co., Inc.
Micronized Metals, Inc.
Vanadium-Alloys Steel Co.

TIN

American Metal Climax, Inc.
Belmont Smelting & Refining Works, Inc.
Glidden Co., The
Chemicals-Pigments-Metals Div.
Greenback Industries, Inc.
Charles Hardy, Inc.
Metal Atomizing & Processing Corp. Ltd.
Metals Disintegrating Co., Inc.
National Lead Co.
Powder Metallurgy Ltd.
Reade Mfg. Co., Inc.

ZINC

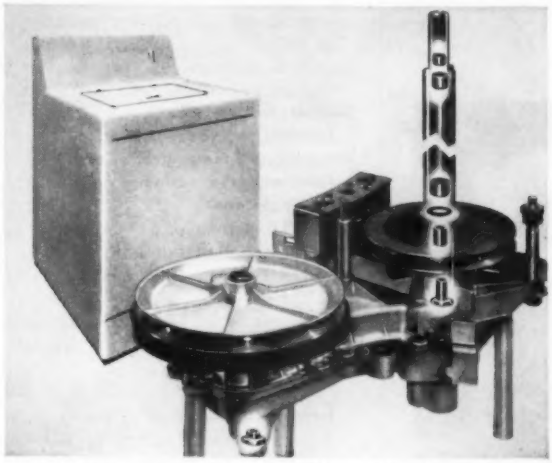
Belmont Smelting & Refining Works, Inc.
Glidden Co., The
Chemicals-Pigments-Metals Div.
Charles Hardy, Inc.
Metals Disintegrating Co., Inc.
New Jersey Zinc Co., The
Powder Metallurgy Ltd.
Reade Mfg. Co., Inc.

METAL POWDERS

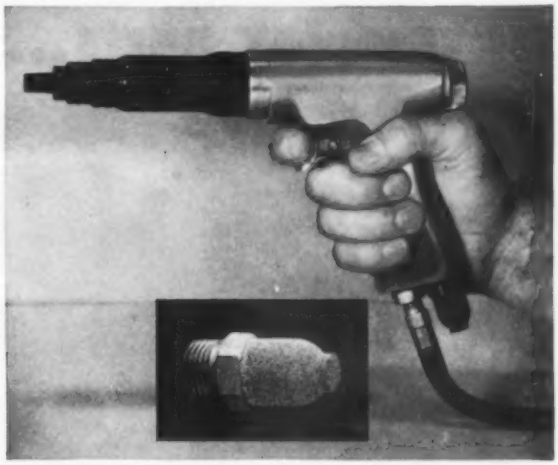
Others

American Metal Climax, Inc.
(bronze filter powders, copperbase alloys, electrolytic silver, atomized solders)
Brush Beryllium Co.
(beryllium, beryllium oxide)

BOOST PRODUCT APPEAL with OILITE

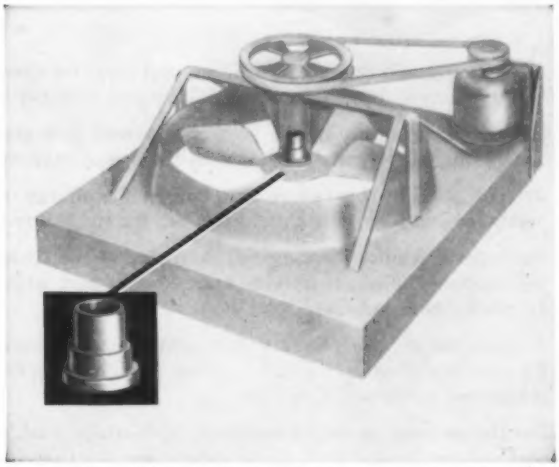


This "best seller" automatic washer is more reliable, more economical with Oilite oil-cushioned bearings.



Oilite filter-diffusers are now boosting the sale of new air tools by making them practically "noiseless".

Dust, grit, shocks — plus payloads up to 34 tons — are all in a day's work for these tough Oilite bearings.



This self-lubricating Oilite bearing refused to fail even after 125 years' service in accelerated life tests.

Quality-built OILITE®* bearings, parts and filters help sell many products by improving performance and keeping costs down. Mass-produced at Amplex's 2 modern plants, even the most intricate parts are die-pressed directly into ready-to-use, close tolerance shapes. Amplex engineering, research and production know-how can probably help you. Why not contact your Oilite representative today? Look for him in the Yellow Pages under "bearings—Oilite" or write Dept. L-4.

** Only Chrysler Makes Oilite*

PM MEMBER

SINCE 1929

A CHRYSLER OILITE PRODUCT

the most trusted name in powder metallurgy!

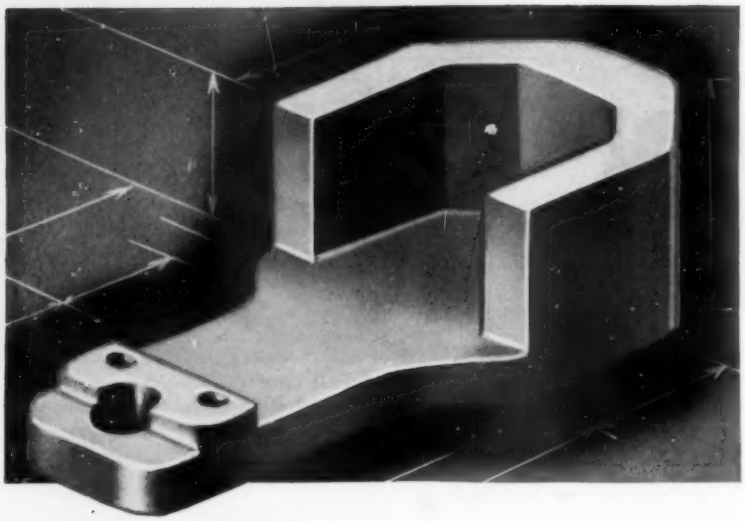
AMPLEX DIVISION

CHRYSLER CORPORATION, DETROIT 31, MICHIGAN

SELF-LUBRICATING BEARINGS • PRECISION PARTS • METAL FILTERS • FRICTION UNITS

For more information Circle No. 19 on the Reader Service Card

economy...speed... in volume production of complex parts...



The photograph shows a bearing support plate for a new line of power tools manufactured and marketed by a large and very capable organization.

The complex nature of the part is apparent at a glance and the cost of machining such a part is evident to the eye of engineer and designer.

It is on parts of this nature that powder metallurgy offers its greatest advantages and its greatest opportunities for the future.

Such parts require most careful designing of the tooling from which they are produced, plus painstaking and tedious effort until the part can finally be produced in volume.

A manufacturer with such requirements naturally turns to Bunting where the necessary persistence until success is achieved is one of the Company's recognized characteristics.

For the unusual, as well as the usual, in bearings, bushings, bars and special parts of cast bronze or sintered metals, see Bunting first.

BUNTING SALES ENGINEERS in the field and a fully staffed Product Engineering Department are at your command without cost or obligation for research or aiding in specification of bearings or parts made of cast bronze or sintered metals for special or unusual applications.

...ask or write for your copy of...

Bunting's "Engineering Handbook on Powder Metallurgy" and Catalog No. 58 listing 2227 sizes of completely finished cast bronze and sintered oil-filled bronze bearings available from stock.

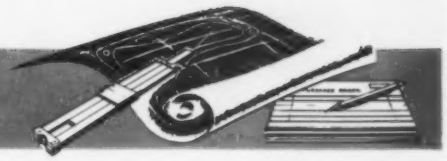
The Bunting Brass and Bronze Company
Toledo 1, Ohio EVergreen 2-3451

Bunting®
Branches in Principal Cities

BEARINGS, BUSHINGS, BARS AND SPECIAL PARTS OF CAST BRONZE OR SINTERED METALS.

For more information circle No. 15 on the Reader Service Card

Federal-Mogul-Bower Bearings, Inc.
(copper-lead and bronze atomized powders)
Foote Mineral Co.
(chromium, electrolytic manganese, zirconium)
Greenback Industries, Inc.
(bronze powder, leaded bronze powder)
Handy & Harman
(silver and gold powder)
Charles Hardy, Inc.
(cobalt, molybdenum)
Hoeganaes Sponge Iron Corp.
(any made to customer specifications)
Kulite Tungsten Co.
(tungsten, molybdenum, cobalt)
Metal Atomizing & Processing Corp. Ltd.
(bronzes – straight Cu-Sn and precipitation – hardening bronzes)
Metal Hydrides, Inc.
(zirconium hydride – Grade R and Grade C, titanium hydride powder, chromium nickel pre-alloyed powder, titanium copper powder, zirconium copper)
Metals Disintegrating Co., Inc.
(babbitt—atomized, bronze—atomized, chromium—milled, filter—special, manganese—milled, nickel-iron—reduced, silicon—milled, silver—atomized—milled, solder—atomized, solder—low temperature—atomized, titanium—milled from sponge, silver solder)
Metals and Residues, Inc.
(molybdenum, tungsten)
National Lead Co.
(cobalt)
National—U. S. Radiator Corp.
Plastic Metals Div.
(manganese, silicon)
New Jersey Zinc Co., The
(bronzes)
Powder Metallurgy Ltd.
(copper/lead, bronze, solder, copper base alloys, alloy powders — non-ferrous)
Powder Metals Research, Inc.
(tungsten, molybdenum, cobalt)
Sherritt Gordon Mines Ltd.
(cobalt)
Shieldalloy Corp.
(tantalum carbide, columbium carbide, tungsten-titanium carbide, titanium carbide, chromium carbide, tungsten carbide, tungsten powder)
Sylvania Electric Products, Inc.
(tungsten, molybdenum)
United International Research, Inc.
(pure, air-stable titanium)
U. S. Bronze Powder Works, Inc.
(iron bearing brass, leaded brass)
Uniworld Research Corp. of America
("SR" Steel)
Vanadium-Alloys Steel Co.
(special iron, nickel, cobalt base powders)



COMPONENTS FABRICATORS

Adamas Carbide Corp.
Kenilworth, N. J.

Aerovox Corp.
Crowley Div.
1 Central Ave.
West Orange, N. J.

Allegheny Ludlum Steel Corp.
20th Floor Oliver Bldg.
Pittsburgh, Pa.

Allied Products Corp.
Powdered Metal Parts Div.
456 E. Cady
Northville, Mich.

American Brake Shoe Co.
5400 W. 130
Cleveland, O.

American Powdered Metals, Inc.
7 Philip Pl.
North Haven, Conn.

American Sinteel Corp.
Sub. of The Mueller Brass Co.
1019 Saw Mill River Rd.
Yonkers, N. Y.

Arnold Engineering Co., The
P.O. Box G
Marengo, Ill.

Arrow Sintered Products Co.
1900 S. Kostner Ave.
Chicago, Illinois

Asco Sintering Corp.
7799 Telegraph Rd.
Los Angeles, Cal.

Bassick Co., The
3045 Fairfield Ave.
Bridgeport, Conn.

Bound Brook Oil-less Bearing Co.
Bound Brook, N. J.

Brockway Pressed Metals, Inc.
921 Clark
Brockway, Pa.

Bunting Brass and Bronze Co.
715 Spencer St.
Toledo, O.

Burgess-Norton Mfg. Co.
737 Peyton
Geneva, Ill.

Carbidie, Inc.
27 Hillview Ave.
Latrobe, Pa.

Carbon City Products Co., Inc.
Ford Rd.
St. Marys, Pa.

Ceromet, Inc.
16233 Gale Ave.
La Puente, Cal.

Chicago Powdered Metal Products Co.
97 Waveland Ave.
Schiller Park, Ill.

Chrysler Corp.
Amplex Div.
P. O. Box 2718
Detroit, Mich.

Cleveland Graphite Bronze
Div. of Clevite Corp.
17000 St. Clair Ave.
Cleveland, O.

Clevite Limited
1177 Talbot St.
St. Thomas, Ont., Can.

Compacted Metals Corp.
99 Greenwood Ave.
Waukegan, Ill.

Custom Components, Inc.
P. O. Box 248
Caldwell, N. J.

Detroit Alum. & Brass Corp.
3975 Christopher Ave.
Detroit, Mich.

Deva-Metal Div.
445 Fifth Ave.
Paterson, N. J.

Dixon Sintaloy, Inc.
535 Hope
Stamford, Conn.

Eaton Mfg. Co.
Powdered Metals Div.
325 Jay St.
Coldwater, Mich.

Eberhart Steel Products
Powdered Metals Div.
317 E. Jefferson Blvd.
Mishawaka, Ind.

Elco Sintered Alloys Co., Inc.
Brussels St.
St. Marys, Pa.

Engelhard Industries Inc.
Baker Contact Div.
207 Grant Ave.
East Newark, N. J.

Engineered Plastics, Inc.
American Sinterings Div.
P.O. Drawer P.
Watertown, Conn.

Fansteel Metallurgical Corp.
North Chicago, Ill.

Federal-Mogul-Bower Bearings, Inc.
11031 Shoemaker Ave.
Detroit, Mich.

Ferro Powdered Metals, Inc.
Box 312
Salem, Ind.

Ferroxcube Corp. of America
Saugerties, N. Y.

Firth Sterling, Inc.
3113 Forbes St.
Pittsburgh, Pa.

Ford Motor Co.
Rawsonville Plant
McKean & Textile Rd.
Ypsilanti, Mich.

General Ceramics Corp.
Crowsmill Rd.
Keasbey, N. J.

General Electric Co.
Magnetic Materials Sec.
Edmore, Mich.

General Electric Co.
Metallurgical Products Dept.
11179 E. 8 Mile Rd.
Detroit, Mich.

General Metals Powder Co., The
130 Elinor Ave.
Akron, O.

General Sintering Corp.
3907 Wesley Terrace
Schiller Park, Ill.

Gibson Electric Co.
Box 547
Delmont, Pa.

Globe Industries, Inc.
Supermet Div.
1468 Cincinnati St.
Dayton, O.

Haller, Inc.
16580 Northville, Rd.
Northville, Mich.

Handy & Harman
82 Fulton
New York, N. Y.

Indar Corp.
2215 Alvord
Indianapolis, Ind.

Indiana Steel Products Co., The
405 Elm St.
Valparaiso, Ind.

International Powder Metallurgy Co., Inc.
439 W. Main
Ridgway, Pa.

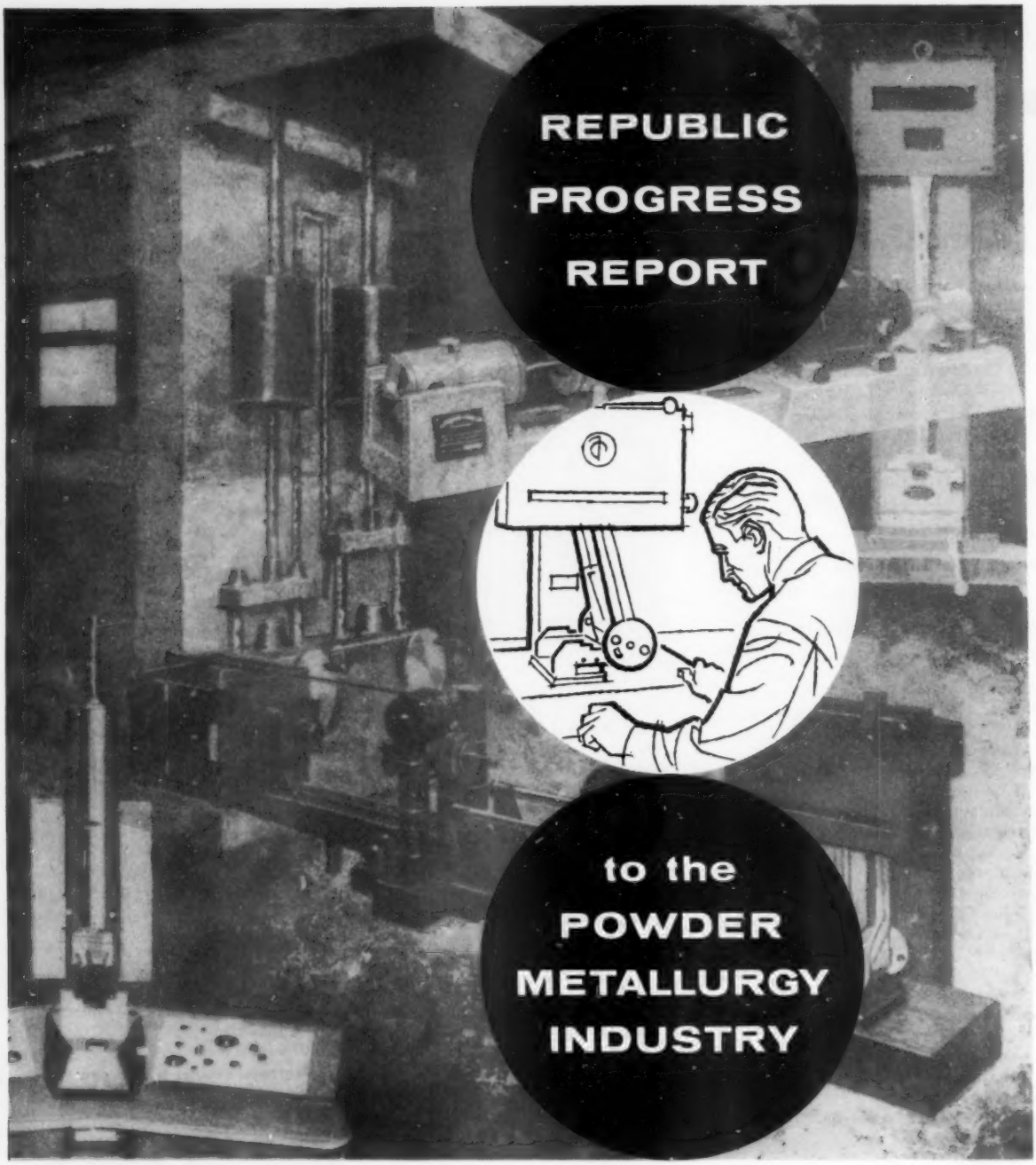
International Powder Metallurgy, Inc.
Rocky Mountain Metals Div., Inc.
3200 N. Century Ave.
Colorado Springs, Colo.

Johnson Bronze Co.
500 S. Mill
New Castle, Pa.

Kennametal, Inc.
Lloyd Ave.
Latrobe, Pa.

Keystone Carbon Co.
State St.
St. Marys, Pa.

Kruse & Slattery, Inc.
1492 Haddon Ave.
Camden, N. J.



ON IMPACT TESTING...

This report is the first of a series to be released by Republic Steel. Other data, normally associated with wrought steel products, are now being developed and accumulated on the physical property characteristics of Republic Iron Powder Types CDF, MS, and HS6460. Information relative to fatigue, creep rupture, dilatometric values, electron microscope studies, and radioactive trace element tests will be forthcoming in the near future.

Preliminary Impact Test Data on Type HS6460 High Strength Powder

SET 1—COMBINED CARBON 0.20%

BRIQUETTING PRESSURE	SINTERED DENSITY	NOTCHED IMPACT STRENGTH	UNNOTCHED IMPACT STRENGTH
60,000	6.33	15 in-lb	63 in-lb
80,000	6.68	22 in-lb	105 in-lb
100,000	6.83	25 in-lb	130 in-lb

SET 2—NO CARBON ADDED

60,000	6.42	22 in-lb	101 in-lb
80,000	6.78	35 in-lb	166 in-lb
100,000	6.96	43 in-lb	200 in-lb+*

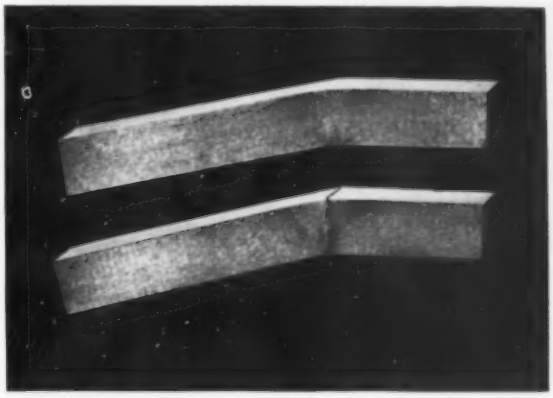
*(value exceeded capacity of impact tester)

Procedure Used to Obtain Impact Test Results

Material—Type HS6460 with 1% zinc stearate. Single press and sintered standard Izod Bars. Sintering conditions for set 1—Endothermic atmosphere, dew point +30°F, 2050°F, 45 minutes at heat (extended time because of size).

Sintering conditions for set 2—Hydrogen atmosphere, 2050°F, 45 minutes at heat.

FREE BOOK—Properties of Republic Type HS6460. This preliminary information illustrates the performance of a typical lot of HS6460, the powder especially developed by Republic to provide excellent carbon compatability for higher stressed structural parts—plus the advantage of excellent heat treat response. Write Republic Steel, Dept. PM-7577, 1441 Republic Building, Cleveland 1, Ohio, for your copy. Ask for ADV. 1028.



Photograph shows single press and sintered Izod Bars after impact testing at 200 in-lb+. Bars did not break.

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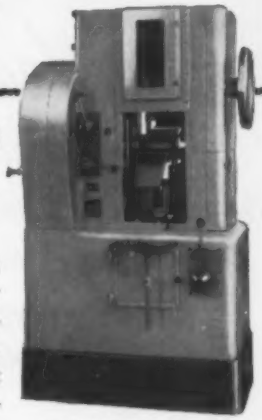

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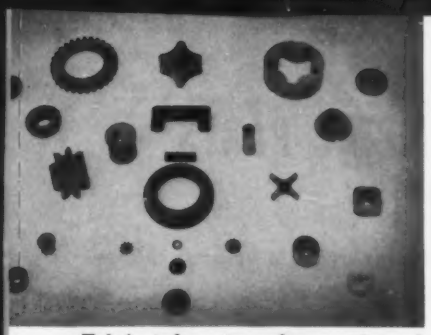
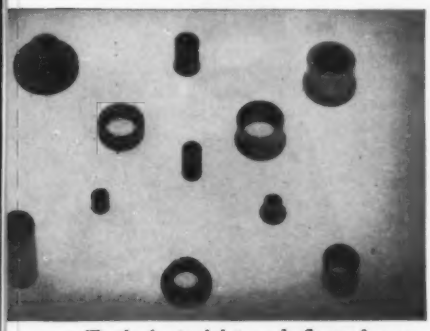
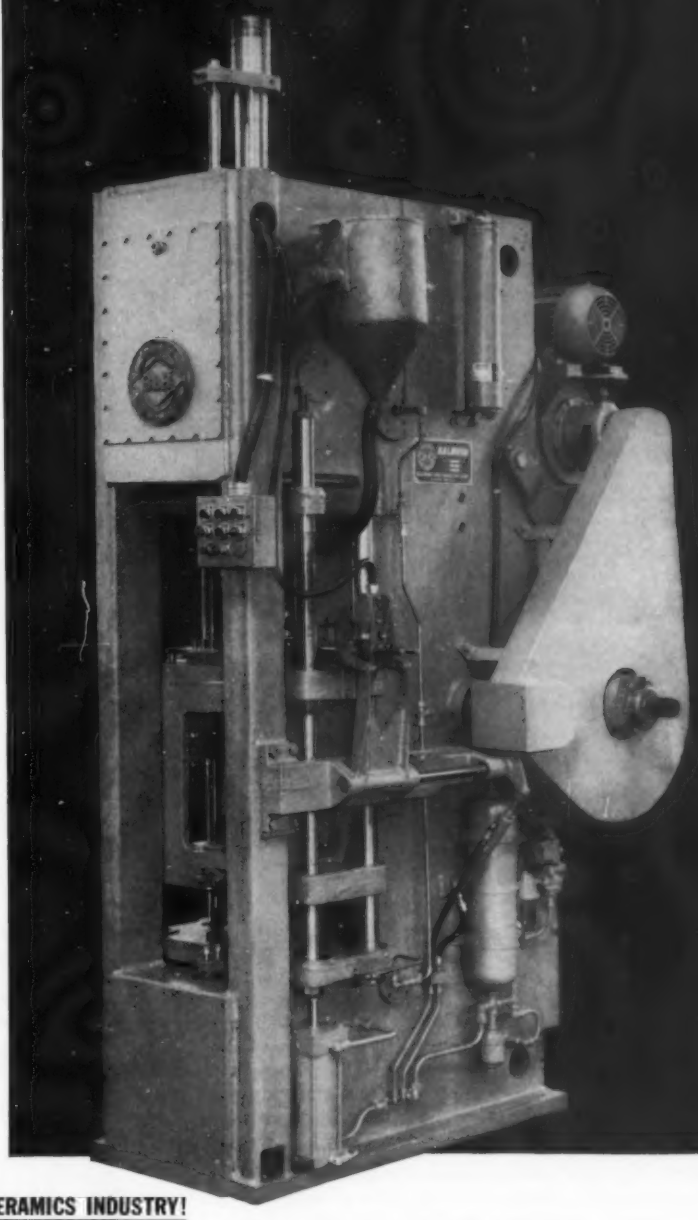


Fabricated parts and gears formed on Baldwin Compacting Presses.



Typical straight and flanged powdered metal bushings made on Baldwin Compacting Presses.

Other parts being made at United States Graphite on Baldwin presses. The double hub and counterbored parts are test pieces. Others are production items.



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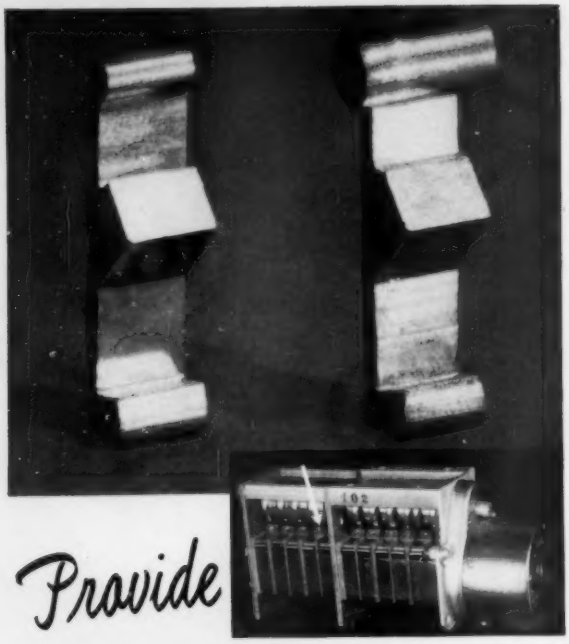

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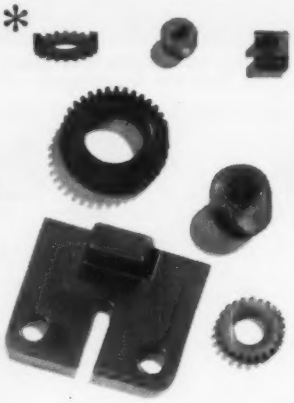

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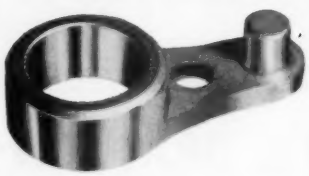

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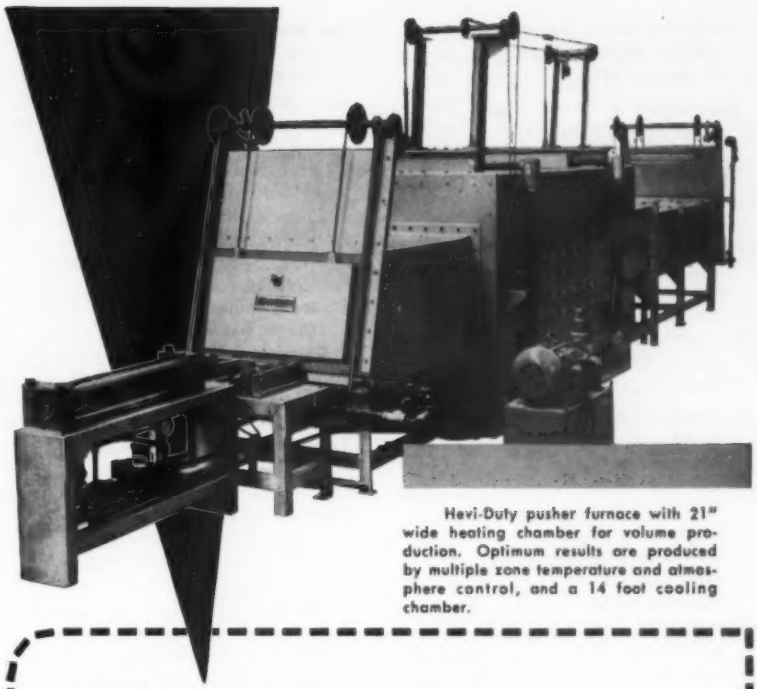

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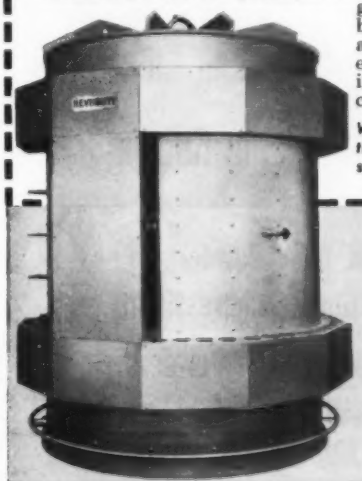

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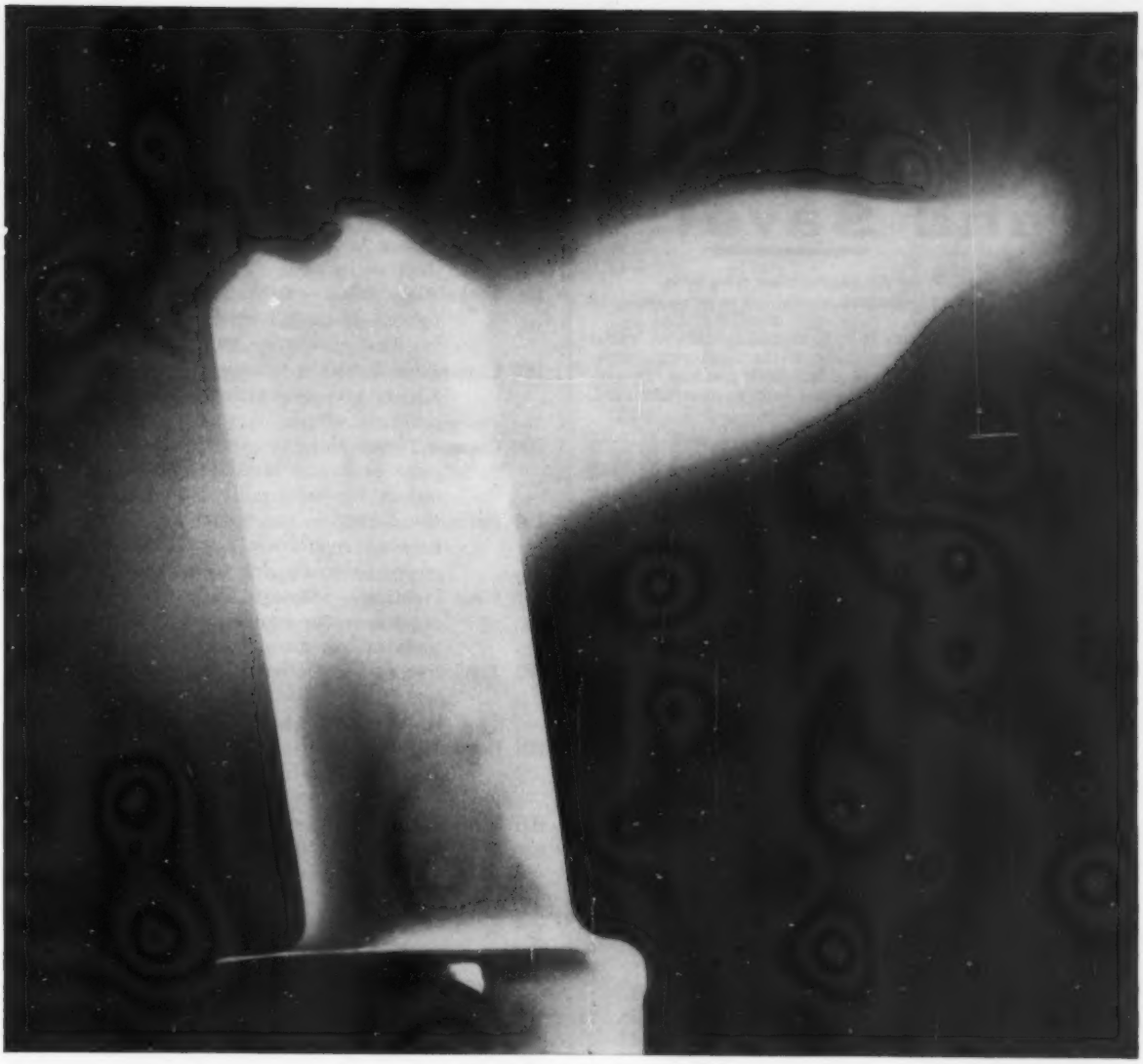

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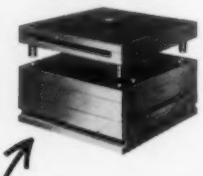

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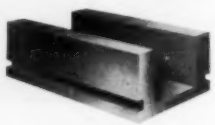

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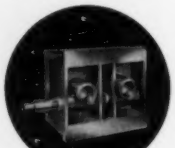

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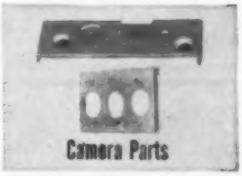
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SINTERINGS IN '59 CARS

continued from page 35

doors. Previously made by die casting which limited the user to lower-strength metals, the iron powder cam is made of SAE, Type 5 material which is gas carburized to achieve the required hardness and strength. The user has recorded no operating problems since the iron powder cam has been put into service. Tolerances required are plus or minus 0.0025 inch. The intricate face-and-disc configuration makes this cam prohibitively expensive to produce by machining from stock.

BEARINGS AND BUSHINGS

Important new advances have also been made in the field of bearings and bushings. Traditionally, sintered bronze bearings were the mainstay of the powder metallurgy business, but the extremely severe requirements for trucks and other special vehicles such as farm tractors have thrown the bearing problem into a completely new category. To retain the original advantages of porous bronze bearings – self-lubrication and close tolerances–and yet to obtain good resistance to extremely high crushing and shock loads, a new order of magnitude in the bearing problem was reached. The availability of larger compacting presses, capable of forming larger and stronger parts – as well as new metal powders with improved properties – is solving this problem. The Amplex Division of Chrysler, for instance, is utilizing a 3,000-ton press to produce sintered iron rings as large as 30 inches in diameter (Figure 6). It is possible now to design rugged transmission systems for unusual vehicles including special military types, without the necessity for designing complex auxiliary lubricating and suspension components.

Another advantage of powder metallurgy – the ability to produce "tailored" special alloy compositions for specific requirements – is being put to good use in bearing surfaces. American Motors and Ford, for example, are using a special sintered copper-lead alloy for the linings of their connecting rod bearings. American Motors has revealed that in some of their 1959 models this special lining will be placed against a 0.05 inch steel backing in semi-circular bearings of approximately 2⅜ inch diameter.

Of course, not all of the powder metallurgy parts in new car designs are in the strictly "structural" category. A great many powder metallurgy parts are listed as "hardware and accessories". A door lock striker plate is a typical example of this type of component – powder metallurgy is used for this part because of the requirements for self-lubrication plus economical production. The use of metallic friction materials made by powder metallurgy methods in brake bands and clutch faces of automatic transmissions continues to increase. This trend is also true for contact materials such as breaker points which are being produced from non-ferrous powders, combining high melting with high conductivity metallic materials.

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MILLES EQUIPMENT & SUPPLY COMPANY

For detailed information send for the "Milles Catalog of Finer Melting Equipment".

THIS CHANGE IS IN KEEPING WITH OUR CONSTANTLY EXPANDING LINE OF SERVICES, EQUIPMENT, AND SUPPLIES. PERSONNEL AND OFFICERS REMAIN THE SAME.

COMPLETE LINE OF MELTING EQUIPMENT FOR DIE CASTERS, NON-FERROUS FOUNDRIES, AND SMELTERS

• Melting Kettles • Ingot Molds • Pallet Molds • Slag Buggies • Ladle Bowls • Thermocouple Protecting Tubes • Milles "Ferrisist" Ladle and Kettle Wash • Pouring Ladles • Pressed and Stainless Steel Ladles and Skimmers • "Di-Alube" Lubricants for Die-Casters • Milles Fluxes for Zinc and Aluminum • Milles Portable Pumps.

This valuable booklet — "Do's and Don'ts for Cast Iron Melting Kettle Operation" — is available on request.

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LOS ANGELES • **INDEPENDENT F'DRY. SUPPLY**, 6463 E. CANNING, LOS ANGELES — RAmond 3-3266
OHIO • **GEORGE E. BOULLAIN**, P. O. Box 285, Franklin, Ohio — Shadyside 6-7043

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milles equipment & supply company

For more information circle No. 72 on the Reader Service Card

FROM BLUEPRINT TO TOP SELLER

Designed to match the famous "Peacemaker 45", P.Y. Hahn's CO_2 powered, 18 shot BB revolver took 45 days from blueprint release to production shipments of finished castings.

The two-piece barrel and the cylinder are zinc diecast in one shot. Die is designed to limit secondary machining to one ream operation and tapping four holes. Gas passages are as-cast. Casting surfaces have no ejector marks, which simplifies finishing operations.

Monarch Exploratory Engineering hit the bullseye in meeting the deadline for shipments against Hahn's heavy advance sales. Let us "trouble shoot" your casting problems.

MANUFACTURING in MOLTEN ACHIEVEMENTS ALUMINUM

MONARCH ALUMINUM MFG. COMPANY

9205 Detroit Avenue Cleveland 2, Ohio

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POWDER METALLURGY ECONOMICS

continued from page 61

DIMENSIONAL ACCURACY

It's quite usual for a print to be submitted to a fabricator with many dimensions specified as ±0.001 or closer. An analysis of the part may show that this close tolerance is specified on a dimension where the part mates with air and a tolerance of $+\frac{1}{4}$, −0.010 would be plenty accurate. Close tolerance work always calls for coining and this may double the tooling costs and nearly double the part cost. So DON'T ASK FOR TOLERANCES YOU DON'T NEED.

PART DESIGN

Before you decide to make, or not to make, a part as a sintering consult your fabricator. It's surprising what these fellows can do. Often at a small increase in tooling cost some expensive machining can be eliminated. Equally often, small modifications of the part to require inexpensive machining after sintering will reduce both the tooling costs and the part costs. Therefore, CONSULT YOUR FABRICATOR BEFORE PART DESIGN IS FROZEN.

COST COMPARISONS

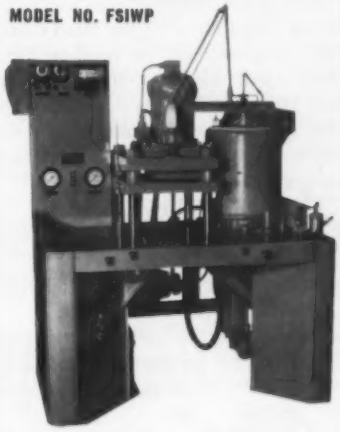
Now let's assume that materials selection has been intelligently made, that tolerances are realistic and that the final design is the most economical for fabrication. How do we compare costs and at what level do we compare costs. Take the second point first. ALWAYS COMPARE COSTS AT EXACTLY THE SAME LEVEL OF COMPLETION. Frequently this will be when the part is ready for assembly.

Now how do we compare costs? Every company has, of course, its own methods of bookkeeping and cost accounting. Such items as inspection, inventory maintenance, scrap disposal and many others may be lumped as general overhead or may be charged to the individual manufacturing departments. But regardless of your company's general policies, the chart given on page 61 has most of the elements required for a good comparison of costs. With little, or no, modification it can be used to determine whether or not a sintering is the most economical.

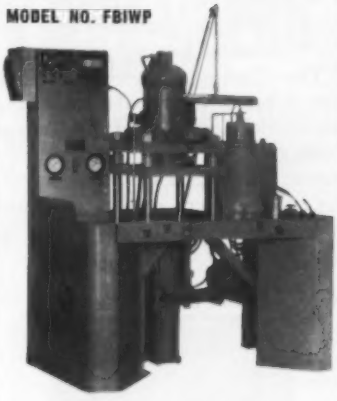
LEYDEN WAX INJECTORS

3 OF OUR MOST POPULAR MODELS

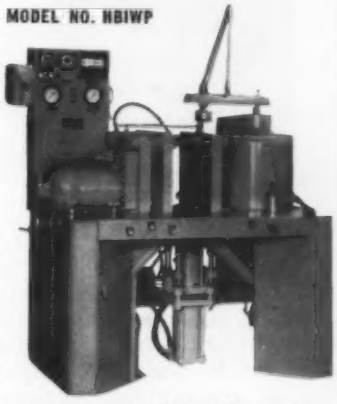
MODEL NO. FSIWP



MODEL NO. FBIWP



MODEL NO. HBIWP



For complete details write direct to Leyden Hydraulics

Any Type or Size Unit Built to Your Specifications.

LEYDEN HYDRAULICS, INC.

1800 North River Rd. • Melrose Park, Ill.

NEWS OF INDUSTRY & ASSOCIATIONS

activities of people, companies & groups in the precision metal molding industries

ENGINEERED CASTINGS SHOW IN CHICAGO THIS MONTH

The 1959 Engineered Castings Show, together with the 63rd Casting Congress, will be held in Chicago April 13-17 at the Sherman and Morrison Hotels. Sponsored by the AMERICAN FOUNDERYMEN'S SOCIETY, the show will be of primary interest to castings users.

Exhibitors will include:

- Companies producing and marketing metal castings.
- Producers of casting metals and alloys.
- Manufacturers of production analysis, inspection, and laboratory equipment for cast metals.
- Companies producing and marketing patterns and dies for metal casting.

The Casting Congress will feature a broad technical-engineering conference. The special needs of castings users will be covered by papers on product-design engineering, plus papers on metallurgical and production developments in cast metals.

JOINS PMM STAFF

GREENE

Stanley S. Greene has joined the editorial staff of PRECISION METAL MOLDING as managing editor. With Industrial Publishing Corp. for eight years, he held the same position on AERONAUTICAL PROCUREMENT and, earlier, MATERIALS HANDLING ENGINEERING. He was a reporter on the Cleveland Press for several years, and has done publicity and public relations work. He attended Case Institute of Technology and Western Reserve University.

HANSON-VAN WINKLE-MUNNING ELECTS DIRECTOR, V. P.

Laurent Oppenheim Jr. has been elected a director and appointed vice president, finance, of HANSON-VAN WINKLE-MUNNING CO. He's also

OPPENHEIM

chairman of the finance committee, Resistoflex Corp., and chairman of the executive committee, Greer Hydraulics, Inc.

MILLES CHANGES NAME

C. H. MILLES FOUNDRY CO. has changed its name to MILLES EQUIPMENT & SUPPLY CO., to reflect its expanding business.

KAISER TO MOVE GENERAL SALES OFFICE

KAISER ALUMINUM & CHEMICAL CORP. will move its general sales offices from Chicago to Oakland, Calif., and the shift will be completed about Sept. 1. The move will bring together Kaiser Aluminum's policy-making groups in management, production, sales, and market development.

Present regional and district sales headquarters will be retained in Chicago, together with technical and field service personnel.

DESIGN ENGINEERING SHOW CONFERENCE SESSIONS SET

Sessions on the choice of materials in design, mechanical aspects of design, and power and control in design will be featured at the fourth annual Design Engineering Conference, sponsored by the machine design division of the AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The conference is held concurrently with the Design Engineering Show, to be held at Convention Hall, Philadelphia, May 25-28.

KOEHRING BUYS CAST-MASTER

KOEHRING CO. has acquired the complete business of CAST-MASTER, INC., through an exchange of stock. Cast-Master will continue operation of its Bedford, Ohio, plant as a division of Koehring's Hydraulic Press Mfg. Div., with all employees joining the Koehring organization.

DOEHLER-JARVIS PROMOTES THREE OFFICIALS

DOEHLER-JARVIS DIV., NATIONAL LEAD CO., has promoted these men: John W. Thees, manager of Toledo Plant I, becomes division production manager; Charles I. Hodgson, sales manager of Toledo Plants I and II, succeeds Thees as manager of Toledo Plant I; Richard M. Hindman, assistant chief engineer for both Toledo plants, succeeds Hodgson as sales manager of Toledo Plants I and II.

THEES

HODGSON

HINDMAN

ROSS JOINS PERMANENT MOLD DIE

ROSS

New chief engineer at PERMANENT MOLD DIE CO. is Frank Ross, formerly vice president, engineering, at Centrocast and Engineering Co. He'd also been chief engineer for Aluminum Alloys Co.

GENERAL EXTRUSIONS NAMES PITTSBURGH REP

DE LUCA

Anthony A. DeLuca has joined GENERAL EXTRUSIONS, INC., as sales representative in the Pittsburgh area. His address is 251 Guenevere Dr., Pittsburgh.

HARRISON IS INTERNATIONAL FOUNDRY SUPPLY PARTNER

HARRISON

Rex Harrison has been named a partner in INTERNATIONAL FOUNDRY SUPPLY CO. Son of the firm's founder, R. B. Harrison, he formerly was sales manager of Reading Gray Iron Castings, Inc. He'll handle national sales of Revecon and Reverbale melting furnaces for non-ferrous and iron foundries.

DUANE SPECIALTIES EXPANDS

DUANE SPECIALTIES, LTD., has leased new and larger quarters for its Newark plant. The new location, at 2 Johnson St., is about twice the size of the old plant, and will also house the company's main offices. In line with the expansion program, orders have been placed for modern, high-pressure equipment of greater capacity.

WHEELON DIRECTOR OF BERYLLIUM CORP.

The election of O. A. Wheelon to the board of directors of THE BERYLLIUM CORP. was announced by Walter R. Lowry, president.

Mr. Wheelon is a consulting engineer and is presently affiliated with Thompson-Ramo-Wooldridge Corp. on ICBM and IRBM programs; with Titanium Metals Corp. of American on vacuum furnace equipment design and allow evaluation techniques; and with Verson All-steel Press Co. on hydraulic press design.

LOCAL BOYS MAKE GOOD WITH LOCAL ZAMAK* USERS

because they give personal service

*also aluminum, bronze, lead, brass, zinc

At HB&S you can

- pick up the phone and get the answer to your question on the spot
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Start-to-finish quality control for alloys

100% on spec.

And yours for the asking Henning's Pocket Guide to Better Casting

Write TODAY for your copy of "Die Casting with Zinc Base Alloys" explaining the factors influencing the production of sound castings and the causes of faults and defects.

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91-117 Scott Ave., at Randolph St., Brooklyn, N. Y.
Smelters and refiners of aluminum, bronze, brass, zinc, lead
Dependable service since 1922

ZINC AND ALUMINUM DIE CASTINGS

- **PRECISION MACHINED**
- **COMPLETE ENGINEERING AND DIE FACILITIES**
- **AUTOMATIC CHROME PLATING**

Our complete facilities, from design to finishing, enable us to meet your varied die casting requirements regardless of size or complexity.

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Wolverine Die Cast Corp.

13700 MT. ELLIOTT
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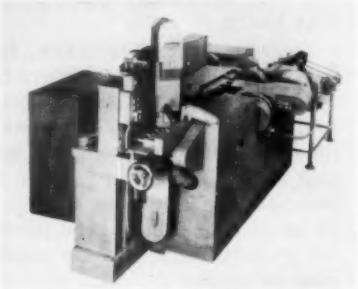
NEW PRODUCTS

continued from page 26

DUST COLLECTOR



AGET MFG. CO. — The Dustkop Model 1150, a compact air-recirculating dust collector suitable for location behind straight line machines and other multiple operations where there is a high dust volume and shop space is at a premium.

Circle No. 243 on Reader Service Card

PORTABLE BARREL FINISHER

RAMPE MFG. CO. — The Rollabrader is a portable barrel finisher that features a lift-off removable barrel, and variable speed drive. The 0.5 cu. ft. machine is ideal for short runs of small parts.

Circle No. 244 on Reader Service Card

CHROME STRIPPER

HANSON-VAN WINKLE-MUNNING CO. — Pickelene 300. A dry mixture that pickles all base metals and also strips chromium. It produces a bright, smut-free surface, and has no objectionable fumes.

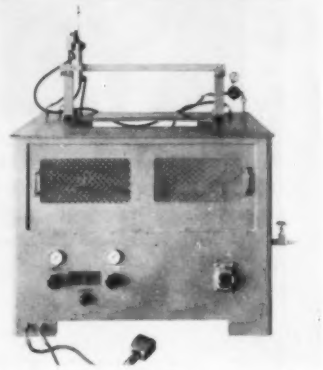
Circle No. 246 on Reader Service Card

ALUMINUM CASTABLE

DEVCON CORP. — Devcon F-2 is a liquid aluminum material, 80% aluminum, 20% plastic, that can be cast without heat or pressure. Two hours after adding a hardening agent, the material becomes a tough metallic mass that has a compression strength of 20,000 psi. Uses include filling of holes incorrectly drilled, building up worn sections, etc.

Circle No. 252 on Reader Service Card

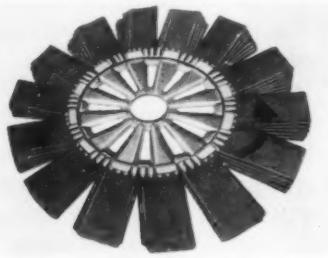
SPRAY PAINTING MACHINE



CONFORMING MATRIX CORP. — Machine features two traversing spray guns. An area up to 8" wide x 22" long can be sprayed. Speed of gun travel is adjustable from 35 to 90 feet per min. The guns will spray in both directions, automatically shutting off at the end of each stroke.

Circle No. 245 on Reader Service Card

POLISHING WHEEL



AMERICAN BUFF CO. — The Uniflex abrasive polishing wheel, when installed ahead of other buffs on an automatic machine, is said to eliminate the need for hand operators and extra polishing operations. It replaces grit application, backstand, contact wheel and idler.

Circle No. 251 on Reader Service Card

FLOW GUIDE METER

FISCHER & PORTER CO. — The Floguide Meter is a metal tube variable-area Flowrator meter with a glass tube indicating extension. It can be used for pulsating liquid or gas flow applications.

Circle No. 261 on Reader Service Card

DRILLED THERMOCOUPLE WELLS

CLAUD S. GORDON CO. — A new line of drilled thermocouple wells, thermometer sockets, and thermometer test sockets. These are for pressure installations to permit checking or replacing of thermocouple or thermometer without opening the line or vessel.

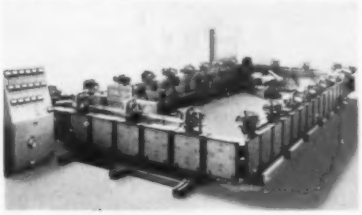
Circle No. 253 on Reader Service Card

VIBRATOR FOR FINISHING

LORD CHEMICAL CORP. — The Lorco Vibrator uses controlled vibration for descaling, deburring, fine finishing. It is also said to burnish or impart color and luster in from 1/100th to 1/10th the time required by barrel finishing.

Circle No. 250 on Reader Service Card

MULTI-PURPOSE CONVEYOR



MURRAY-WAY CORP. — Conveyor design features horizontal and vertical platens and sealed line construction. The unit is available in rectangular or straight-line design. It can be equipped with continuous drive or variable station-dwell.

Circle No. 257 on Reader Service Card

DIFFUSION PUMP

NRC EQUIPMENT CORP. — Model H-32-P, a 32" vacuum oil diffusion pump, has a top speed above 50,000 CFM at an inlet pressure of 1×10^{-4} mm. Hg. (atmospheric pressure = 760 mm. Hg.) and speeds above 30,000 CFM at pressures between 3.5×10^{-4} and 6×10^{-6} mm. Hg.

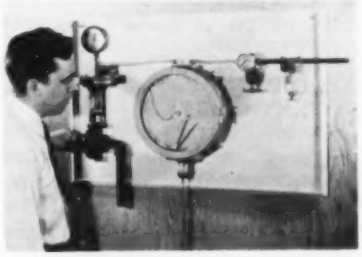
Circle No. 254 on Reader Service Card

DRY FILM LUBRICANT

MIRACLE POWER PRODUCTS CORP. — "dfg 123" is a high-efficiency, non-inflammable colloidal graphite lubricant designated as a dry film material. Uses include application to prevent dry rubbing contact during initial movement of bearing surfaces, and subsequent run-in.

Circle No. 249 on Reader Service Card

TEMPERATURE CONTROLLER



PARTLOW CORP. — A low-cost pneumatic recording temperature control. The control utilizes a 15 lb. air line to actuate an air-operated steam valve. It is available in 10 optional temperature ranges within –30 to 1100 F.

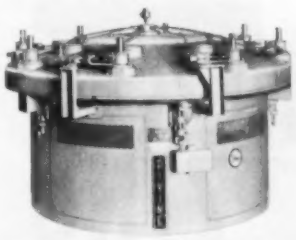
Circle No. 255 on Reader Service Card

AMMONIA DISSOCIATORS

C. I. HAYES, INC. — The AD-52 and AD-61 are two new dissociators for producing research and production atmospheres in the 100 CFH and 150 CFH capacity ranges. The furnace atmospheres produced are good for bright brazing, powder metallurgy processes, etc.

Circle No. 248 on Reader Service Card

ROTARY CONVEYOR



DIVINE BROS. CO. — The RV-X Rotary Conveyor, indexing type, is for polishing, buffing or brushing head units. It has a 72" diameter table which contains 8 fixture spindles on a 66" diameter centerline.

Circle No. 260 on Reader Service Card

continued on page 112

THE PIERCE-WALLER
AIR-LUBE
SYSTEM
CUTS COSTS for DIE-CASTERS
• CLEANS
• LUBRICATES
Remove loose flash and clean the mold with a powerful, clean air blast — then lubricate all mold surfaces evenly, using the same gun —with a flick of the thumb! Adjustment at the gun for full range from zero to a heavy mist, spraying, fogging, or vaporizing the lubricant. Speeds up mold operation and reduces casting rejects. Makes every machine cycle count.
USED IN LARGE AND SMALL SHOPS EVERYWHERE!
WRITE FOR FREE FOLDER
PIERCE-WALLER, INC.
P.O. Box 2121A • DAYTON 29, OHIO
Plant: RAJAK MFG. CO.
Specialists in polyester impregnation of metals
245 N. Fourth St. • Tipp City, Ohio

Circle No. 78 on the Reader Service Card

NEW PRODUCTS

continued from page 111

VACUUM COLD TRAP

VEECO VACUUM CORP. — The Veeco CT-400 Cold Trap provides 8-10 hrs. continuous operation from 1 filling (0.6 liters) of liquid nitrogen. The BAF-400 Baffle has an internal cooling coil and an external coil to condense almost all backstreaming oil molecules. Both units are flanged to mate with other of the company's 4" systems.
Circle No. 247 on Reader Service Card

CENTRIFUGAL WASHER-DRYER

LEON J. BARRETT CO. — A high torque, reversible motor makes it possible for Barrett Centrifugal Washer-Dryers to handle loads up to 425 lbs. The reversible motor makes it possible to rinse and dry irregular parts with deep recesses or blind holes.
Circle No. 256 on Reader Service Card

RECORDING POTENTIOMETER

WESTON INSTRUMENTS, DIV. OF DAYSTROM INC. — The Model 6702 Daystrom-Weston multipoint recording potentiometer is capable of handling from 2 to 24 points by means of plug-in adapter units.
Circle No. 258 on Reader Service Card

ULTRASONIC GENERATOR

BRANSON ULTRASONIC CORP. — Model APT-500 Sonogen generator has a 3-kw average power output and will activate 300 gallons of cleaning solution. The unit features a remote control panel, which can be incorporated with other instruments at a central control area.
Circle No. 259 on Reader Service Card

LOCKING DRIVE PINS

GROOV-PIN CORP. — Locking drive pins that measure 1/32" in diameter x ⅛" to ½" in length are suited for connecting or locking together two miniature parts. Uses include replacing plain pins or bent wire fasteners.
Circle No. 262 on Reader Service Card

STATIC EXCITER-REGULATORS

KATO ENGINEERING CO. — Single unit static exciter-magnetic amplifier regulator units, that replace both the conventional rotating exciters and electro-mechanical types of regulators, have been developed for AC generator control units.
Circle No. 263 on Reader Service Card

ZINC RICH PAINT

BART MFG. CORP. — Galvafroid. A zinc rich paint that contains from 92% to 95% of metallic zinc in the dry film. This gives protection comparable to hot-dip galvanizing.
Circle No. 267 on Reader Service Card

SELLERS OF

'METALKAT'
BRAND ELECTROLYTIC ZINC
SPECIAL HIGH GRADE 99.995% +
HIGH GRADE 99.95%

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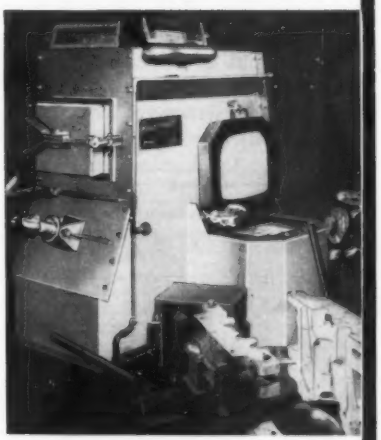
Today's most efficient..compact

DIP-OUT
FURNACE
for
ALUMINUM & BRASS
Permanent Mold Casters

Reverbale
SELF-CONTAINED MELTING AND HOLDING UNITS

by the makers of
famous **REVECON** furnaces



The REVERBALE furnace reduces MELTING AND MAINTENANCE COSTS 66% . . . KEEPS METAL LOSS BELOW 2%!

No crucibles required . . . EASIER CHARGING OF INGOTS . . . waste gases used for pre-heating . . . NO CHILLING OF METAL BATH WHEN ADDING FRESH INGOTS . . . greatest possible flexibility when changing metals.

WRITE NOW for our informative booklet: "International Formula To Cut Melting Costs In ½"

INTERNATIONAL Foundry Supply Co.
P.O.Box 1053 Reading, Pa. Phone: FR 6-0794

Canadian Representative: Drew Brown Ltd. 5410 Ferrier St., Montreal 9

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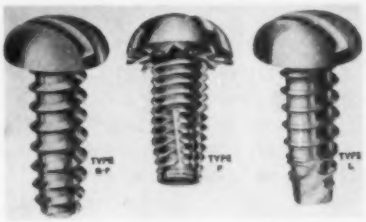
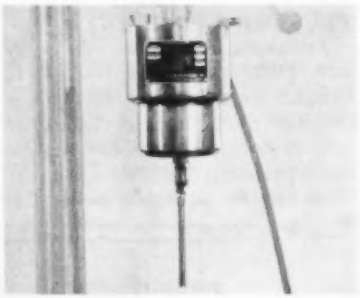
THREAD-CUTTING SCREWS



PARKER-KALON — 3 thread cutting screws: Type F cuts a machine screw thread; Type B-F has widely-spaced threads with a coarse pitch. It can be used for fastenings in thin sections and bosses in brittle materials; Type L functions as a combination thread-cutting and thread-forming screw.

Circle No. 266 on Reader Service Card

METAL DISINTEGRATING MACHINE



JIFFY DISINTEGRATORS, INC. — Model J-2. The unit operates on a electro-magnetic principle. Uses include removal of broken taps, drills, reamers, studs, etc. Also, it can burn shaped holes into hardened metals.

Circle No. 271 on Reader Service Card

ANODE HOOKS

MALLORY-SHARON METALS CORP. — Titanium anode hooks and baskets that have extremely high corrosion resistant qualities. Standard range size is from 3½" to 8".

Circle No. 272 on Reader Service Card

MECHANICAL FINISHING MACHINE

ABRADO FINISH CORP. — Abrado-Matic Model TS-31 is for the mechanical finishing of external surfaces of high-precision, machined parts. One or more parts can be attached to a fixture that automatically lowers into a rotating tub of abrasive media.

Circle No. 273 on Reader Service Card

continued on next page

Thousands of extra pours per ladle, with less effort for the operator
the Spincraft STAINLESS STEEL ladle
for non-ferrous metal pouring

LIGHT
TOUGH
LONGER-LASTING

If you pour non-ferrous alloys, Spincraft ladles will save you replacement costs and make the job much easier. Designed to reduce operator fatigue by their lightness, balance, and non-spill shape, they resist burning-through as only stainless steel with its high critical melting point can do. Spincraft ladles come in 23 sizes, from ¼ lb. to 30 lb. molten metal capacity.

- 75% lighter than cast iron ladles
- Amazingly long life
- Shot-blasted for coating adhesion
- Deep conical form makes pouring easier, minimizes spillage
- Can be used for zinc and other metals without coating
- "Whack proof" handle arc-welded to reinforced cup edge
- Built to last longer, work lighter. Let your operator use one, then try to take it away from him!

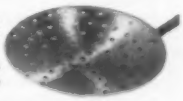
Complete handle on ¼ lb. through 9 lb. size; 10 through 30 lb. size has handle bracket stub to which proper length handle can be attached.

Also...Spincraft STAINLESS STEEL Skimmer

A skimmer that really skims! Shallow radius skims surface impurities instead of ladling as deeper-cupped skimmers do. Correct size holes prevent clogging. Short handle stubs fit common pipe and permit attachment of length and type handle you want.

IN FOUR DIAMETERS: 6 inch, 8 inch, 10 inch, 12 inch.

Spincraft ladles and skimmers are also available in low-cost mild steel.



Write for complete data and prices today.

Spincraft
SPINCRAFT WILL DO IT

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Send us complete information on:

Stainless Steel	Mild Steel
☐ Ladles	☐ Ladles
☐ Skimmers	☐ Skimmers

Company .....
Address .....
City ..... State .....
Name .....

Circle No. 85 on the Reader Service Card

Dodge Custom-made **Special Alloy Steel Goosenecks**

. . . for longer service life

. . . less maintenance

Here's the biggest news in die casting in years: a custom-made special alloy *steel* gooseneck that will outlast and outperform iron and alloy iron goosenecks currently available . . . and provide greater operational savings! Developed through years of experience and association with the die castings industry, Dodge Special Alloy *Steel* Goosenecks provide many advantages:

- Will outlast iron and alloy iron goosenecks by as much as 4-5 years.
- Maintenance problems are fewer because of long service life.
- Down time is reduced to a minimum because of long service life.
- Designed and made of special alloy *steel*, they prevent cracking . . . bottom breakout . . . spout erosion.

Each Dodge Special Alloy *Steel* Gooseneck is custom made to specifications by the Finished Products Division of Dodge Steel Company. Facilities are available for producing any size gooseneck for any die casting machine. Goosenecks are furnished either rough machined or machined with sleeves. Dodge provides a complete engineering service in the designing and production of steel goosenecks.

Your inquiries are solicited, without obligation, of course. Ask too, about pots and other die casting machine parts including nozzles, spouts, plungers, etc.

DODGE STEEL COMPANY

FINISHED PRODUCTS DIVISION
6501 Tacony Street
Philadelphia 35, Pa.

THE MOST IMPORTANT ALLOY IN A STEEL CASTING IS QUALITY

Circle No. 30 on the Reader Service Card

NEW PRODUCTS

continued from page 113

ALUMINUM BAR FOR BEARINGS

BUNTING BRASS & BRONZE CO. — Aluminum bars, which can be machined to fit any bearing use, are now available. The bar is an aluminum-tin alloy with certain other metals such as copper, nickel and magnesium added to assure fine bearing properties.

Circle No. 268 on Reader Service Card

HIGH SPEED STRIPPER

LEA MFG. CO. — Coldstrip #900 is a high speed stripper for removing enamels, lacquers, and resin base coatings at room temperature.

Circle No. 264 on Reader Service Card

PLUNGER LUBRICANT

AMERICAN CHARCOAL CO. — Dylube #400. A series of plunger lubricants for cold chamber die casting machines. The lubricants are said to reduce shot sleeve replacement problems by 75%.

Circle No. 265 on Reader Service Card

EJECTOR PINS

DETROIT MOLD ENGINEERING CO. — Letter-size diameter ejector pins. Available in standard 10" lengths. They are made from heat-treated die steel, ground, nitrided, honed.

Circle No. 269 on Reader Service Card

HYDRAULIC FLUID

MONSANTO CHEMICAL CO. — Pydraul A-200. An all-synthetic hydraulic fluid which combines low cost with extreme fire-resistance and lubricating properties. Features high resistance to compression, and excellent lubricity.

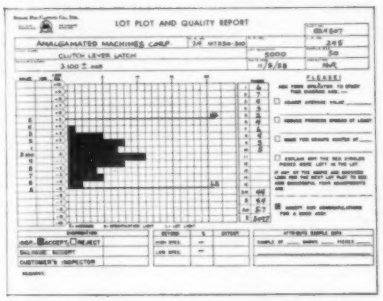
Circle No. 102 on Reader Service Card

INCREASED SALES STAFF FOR NEW JERSEY ZINC

Three new sales representatives have been added to the metal sales staff of NEW JERSEY ZINK CO. Rupert C. Bing will cover the eastern area from the New York office. Robert D. Burns will cover the midwestern area out of Chicago. John P. Del Vecchio will be a technical service representative with headquarters in New York.

STROH INTRODUCES STATISTICAL QUALITY CONTROL FOR DIE CASTINGS

DIMENSIONAL CONTROL AT STROH DIE CASTING BEGINS WITH A CHART LIKE THIS . . .



Here's what the new concept of Quality Control at Stroh Die Casting means to you

CRITICAL DIMENSIONS can be held within specified limits. Buyers who rely on statistical dimensioning to assure accurate parts for assembly are invited to consult Stroh.

LOWER INSPECTION COSTS come from simpler receiving inspection instead of full sampling of each shipment of die castings. Many manufacturers now benefit from Stroh's Quality Control.

Write for Details

IN OUR 56th YEAR

Stroh Die Casting Co., Inc.

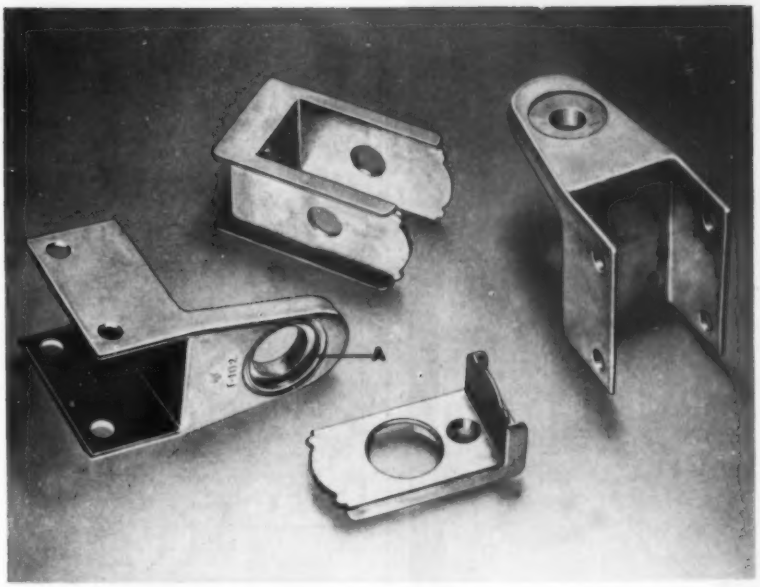
11123 WEST BURLEIGH STREET
MILWAUKEE 10, WISCONSIN

For more information circle No. 87 on the Reader Service Card

DESIGN FOR
DIE CASTINGS

Cast hardware . . .

Looks Good, Works Good, Fits Good



CLOSE FIT, STRENGTH, CLEAN FINISH. These were the requirements spelled out by a customer who wanted to lower costs by die casting hardware used on steel partition doors.

Before any tooling was designed, Monarch Aluminum Mfg. Co. engineers worked out preliminary problems with the customer, such as locating parting lines and ejector pins to provide clean casting surfaces suitable for chrome plating.

One of the parts (Figure A) was designed with a raised lip to seat a nylon bushing. This lip, crimped over the bushing, eliminates an assembly operation. Also, normal draft allowances on critical surfaces were reduced (some were eliminated) so that the castings would fit properly.

The parts, formerly brass stampings, are die cast in zinc in a four-cavity unit die. Dimensions of the largest part are 2 x 1½ x 3¼ in., and it weighs 5 ounces.

BEST
FOR
UPSETTING
PIERCING
EXTRUDING
FORGING

PRODUCES MORE AND BETTER PIECES BETWEEN DIE CHANGES.

A graphited product for use in working hot metals of all kinds. Good in temperatures up to 2200° F and above. Keeps work cool and extends the life of dies and punches. Highly adhesive, may be applied by brush or swab or diluted with oil for spraying.

Bulletins describing Fiske's 514A Hot Die Lubricant and other specialty lubricants and coolants sent on request.

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Since 1870

METAL WORKING LUBRICANTS

FISKE BROTHERS REFINING CO.
129D LOCKWOOD STREET, NEWARK 5, N.J.
Plants: Newark 5, N. J. and Toledo 5, Ohio

For more information circle No. 33 on the Reader Service Card

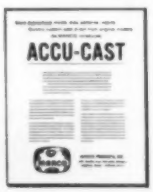
Die Inserts for Zinc or Aluminum Are **ACCU-CAST®** By Shaw Process

MANCO

ACCU-CAST* components for die-casting are produced in Nu-Die V, VDC, or other hot-work steels to close tolerances.

Casting from original patterns eliminates need for master hobs and prolonged machine cutting of cavities and cores . . . provides cost savings, greater design leeway, fidelity of detail, and excellent surface finish.

Manco's UQC (Uniform Quality Control) and long experience assure sound, trouble-free components for exacting requirements.



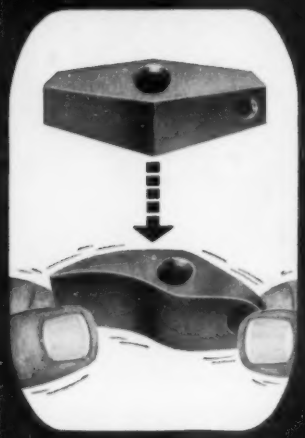
FREE: copy of ACCU-CAST technical bulletin. Write, wire, or phone:

MANCO PRODUCTS, Inc.
2401 Schaefer Road, Melvindale, Mich.
Telephone: Detroit—WArwick 8-7411
Representatives In Principal Cities

*Licensed under Shaw Process

For more information circle No. 58 on the Reader Service Card

just to *stretch* a point.



. . . Next time specify
INVESTMENT CASTING

Parts design becomes as flexible as wax when you specify Investment Casting. Because with this "lost wax" process, parts can be designed for function; for utmost operating efficiency rather than compromised to satisfy a method of manufacture.

Costly machining and assembly operations are reduced and often eliminated. Complex and time consuming tooling setups too! And — you have the widest selection of alloys from which to choose: the non-ferrous group, the carbon and low alloy steels, the hard-to-form, hard to machine high alloy steels . . . even cobalt base alloys.

Thus you stretch your design potential, you stretch your range of metals and you stretch your budget when you specify this process.

It might stretch your imagination too, if you could see some of the intricate shapes we're casting here at Hitchiner. If you'll write us today for our free new brochure, you'll get an idea how you can utilize the freedom and savings offered with Investment Casting.

For complete details, see this new illustrated, informative booklet on the art of Investment Casting. It could be the best investment you ever made.

HITCHINER
MANUFACTURING COMPANY, INC.
MILFORD 45, NEW HAMPSHIRE
Representatives in Principal Cities

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PMM OPPORTUNITIES

jobs & equipment

Opportunities rates: $20 for the first column-inch; $15 for each additional column-inch payable in advance. To answer box number advertisements, address responses to the box at Precision Metal Molding. 812 Huron Rd., Cleveland 15, Ohio. Closing date: 1st day of month preceding publication.

POSITIONS OPEN

SUPERVISOR OF
DIE CASTING DEPARTMENT

New Los Angeles factory of national concern interested in man to set-up and supervise new die casting dept. Must have thorough knowledge of die casting, trimming, die maintenance, and repair. Send complete resume to Box No. 4159.

REPRESENTATIVE WANTED—Leading West Coast manufacturer of powdered metal products and electronic cores seeks well-qualified commission representatives with following in OEM for Central, Pacific Northwest and Southeastern States. Write Sales Manager, Kwikset Powdered Metal Products, Anaheim, California.

DIE CASTING — DIE DESIGNER — The Western Electric Co., Manufacturing and Supply Unit of the Bell Telephone System, has immediate opening in Baltimore, Md., for design engineers experienced in the design of aluminum die casting dies. Graduate engineer preferred but will consider equivalent experience and education. In addition, experience in injection mold design and tool and die design desirable. This is an excellent opportunity in a progressive company. A personal interview in Baltimore (expenses paid) will be arranged for qualified candidate. Liberal relocation allowance will be granted if employed. For a prompt reply write to Western Electric Company, Employment Manager, 2500 Broening Highway, Baltimore 24, Maryland, giving age and a brief outline of education and experience.

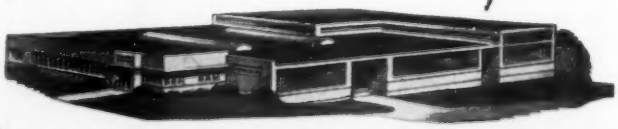
Get the results you want from DIE CASTING...

When you decide to use die cast parts, you expect, definite *results* in terms of *benefits* reflected in your manufacturing operations, or in your finished products. Milwaukee engineers and technicians, backed by the complete facilities of the modern Milwaukee plant, are qualified by training and experience to give you the results you are looking for . . . and more!

When you send your prints and "specs" to Milwaukee, you often get more than a quotation. You may get suggestions and proposals, when deemed useful, that will give you all the results you are looking for plus the *extra benefits* which the die casting process can give you.

Milwaukee operates under the Certified Zinc Plan of the American Die Casting Institute.

A partial list of RESULTS you can expect when you specify
MILWAUKEE DIE CASTINGS
★ Less Machining
★ Improved Design
★ Closer Tolerances
★ Smoother Finish— at lower cost
★ Stronger Sales Appeal
★ Faster Assembly



MILWAUKEE DIE CASTING COMPANY
4146 N. HOLTON STREET • MILWAUKEE 12, WISCONSIN
Established 1909

For more information circle No. 61 on the Reader Service Card

WANTED: B & T Machinery Company, Holland, Michigan, needs serviceman for its line of die casting machines, trim presses and research laboratory facilities. Experience in hydraulics, electricals and die casting required. Must be willing to relocate in Holland. Call: J. C. Petter, EX-2-2341, B & T Machinery Company.

EQUIPMENT

FOR SALE: Precision foundry, fully equipped for non ferrous metal including magnesium. Equipped for investment, plaster mold and CO_2 sand processes. Has been operated as captive foundry at rate of $100,000 per yr. Capacity $500,000. New York City location. Box No. 4259.

TECHLINE OPENS LAB

TECHLINE DIV., WHEELABRATOR CORP., has opened a new chemical laboratory in conjunction with the processing laboratory at its Vicksburg, Mich., plant. The new laboratory will have facilities for research and development of barrel finishing compounds.

Mason Atkins, former field engineer specializing in wet blast precision finishing for Wheelabrator, was named chief chemist at the lab.

PLAN DESIGN CLINIC FOR MPI SHOW

A design clinic for powder metallurgy will be held at the METAL POWDER INDUSTRIES FEDERATION'S 1959 Powder Metallurgy Show scheduled for April 20-22 at the Sheraton-Cadillac Hotel, Detroit. Sponsored by sintered parts fabricators, the clinic will be directed at designers and engineers to show them what today's powder metallurgy has to offer.

MILWAUKEE DIE CASTING NAMES CHIEF DESIGNER

Albert W. Kreutzberger has joined MILWAUKEE DIE CASTING CO. as chief designer. Active for many years as a tool and die designer, he'd been chief die designer of outboard motor castings for a motor producer for the past seven years.

To make the BEST...
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BEST CASTINGS!

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Latrobe Die Casting Co.
Latrobe, Pennsylvania

Established 1918

For more information circle No. 55 on the Reader Service Card

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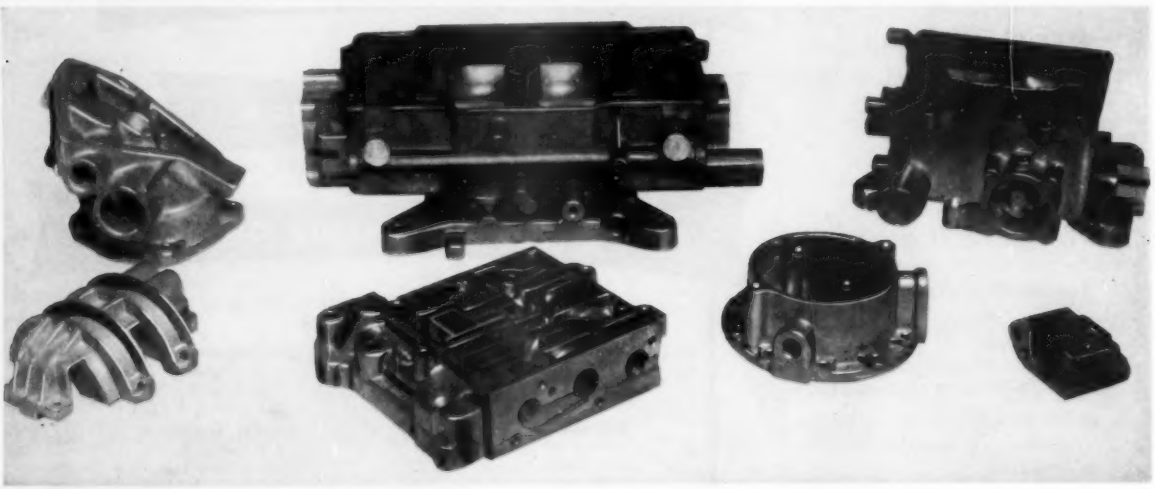

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Specialists in Die Cast Dies — Plastic Molds — Powder Metal Molds — Wax Molds for Investment casting.

The latest in toolroom equipment assures you of precision workmanship and prompt delivery. Design and build complete dies, or cavities to fit your die.

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For more information circle No. 76 on the Reader Service Card

PMM DATA OFFERED IN THIS MONTH'S ADS

the Reader Service Cards facing the last page will get you these free reference materials. Circle the numbers and mail.

2. Tool Steels—Publication list from Allegheny Ludlum Steel Corp., gives data on more than 125 technical publications offered by the company.

6. Metal Preservative—Technical literature describes Enteks, a new series of rinse water additives that give metal surfaces a protective coating against the atmosphere. Enthone, Inc.

10. Investment Casting—"Practical Guide to Investment Casting", is a 44-page design handbook from Arwood Precision Casting Corp.

11. Metal Powders—Technical data on AMAX non-ferrous metal powders is available from American Metal Climax, Inc.

14. Compacting Press—A new low-cost compacting press, designed for versatility and having a rated pressure of 50 tons, is described in technical literature from the Hamilton Div., Baldwin-Lima-Hamilton.

15. Sintering—The "Engineering Handbook of Powder Metallurgy", and Catalog No. 58, which lists 2,227 sizes of completely finished cast bronze and sintered oil-filled bearings, are available from Bunting Brass & Bronze Co.

17. Silicon Carbide Tile—Technical data from the Refractories Div., The Carborundum Co., describes Carbofrax, a silicon carbide tile that has almost as much heat conductivity as chrome-nickel steel.

20. Die Casting Machine—Technical data describes a machine that has 650-tons locking pressure, and will handle a shot of 10.6 lbs. aluminum, 25.8 lbs. zinc. The Cleveland Automatic Machine Company.

25. Standardized Die Components—which reduce design time and cut die construction costs, are described in a 170-page catalog. The Detroit Mold Engineering Company.

29. Die Castings—A 16-page facilities folder from the Dollin Corp. gives their die-casting techniques for solving rigid design requirements in zinc and aluminum castings.

31. Hydraulic Compacting Presses—in capacities from 2 to 75 tons, that feature an exclusive shuttle-feed with rotary agitator for compacting, is described in Bulletin M-11-B. Denison Engineering Div., American Brake Shoe Co.

32. Sintering Furnaces—Bulletin No. 461 shows typical installations of EF gas-fired, oil-fired and electric furnaces. The Electric Furnace Co.

33. Metal Working Lubricants—Fiske Brothers Refining Co. offers technical bulletins on their 514A Hot Die Lubricant and other specialty lubricants.

36. Small Die Castings—Technical data from Gries Reproducer Corp. explains their "Intercast" method of producing small zinc-alloy parts with moving elements in a single automatic operation.

39. Sintering Furnaces—Engineering data on tube, pusher, box and mesh belt type sintering furnaces. Harper Electric Furnace Corp.

40. Zinc Die Casting Facts—Henning Bros. & Smith, Inc. has issued an engineering data book on "Die Casting With Zinc Base Alloys".

41. Sintering Furnaces—for controlled atmosphere or vacuum sintering are described in technical literature from Hevi-Duty Electric Company.

42. Investment Casting—Brochure from Hitchiner Mfg. Co., gives technical data on utilizing the freedom and savings offered with investment casting.

49. Furnaces—for aluminum and brass permanent mold casters. Technical booklet gives data on cutting melting costs in half. International Foundry Supply Supply Co.

50. Sinterings—Technical literature is available on Johnson Ledaloyl Powder Metallurgy for bronze or iron bearings, bushings, and parts. Johnson Bronze.

52. Compacting Presses—A complete catalog from Kux Machinery Co. gives engineering data on their presses that feature push button control, positive mechanical pressure stop mechanism, secondary lower punch mechanism, etc.

54. Induction Heating Units—from Lepel High Frequency Laboratories, Inc., for brazing, melting, annealing, etc. are presented in an engineering catalog.

56. Hot Work Steel—VDC hot work steel, air hardening, high vanadium, Type H-13, for die casting dies, is described in engineering data sheets from Latrobe Steel Co.

57. Die Casting Machines—Information on a complete line of die casting machines is available from Lester-Phoenix, Inc. The units feature reliable clamping, and are readily adapted to vacuum casting.

58. Die Casting Components—Accu-Cast by the Shaw Process, are described in a technical bulletin from Manco Products, Inc.

67. Zinc Die Castings—The "End Uses of Zinc Die Castings", is a 62-page booklet on the uses of zinc die castings in American manufacturing. The New Jersey Zinc Co.

68. Cutting Costs—with brass powder metallurgy. Engineering data booklet evaluates this production method in terms of particular needs. The New Jersey Zinc Co.

72. Melting Equipment—Catalog describes complete line of melting equipment for die casters. Also the booklet, "Do's and Don'ts For Cast Iron Melting Kettle Operation", is available. Milles Equipment & Supply Co.

73. Aluminum Ingot—Technical data bulletin on aluminum pig and ingot. Metals Div., Olin Mathieson Chemical Corp.

75. Lubricants—for powdered metal molding, that reduce molding and ejection pressure, are described in technical literature from M. W. Parsons-Plymouth, Inc.

78. Cleans, Lubricates—That's what the Air-Lube System, manufactured by Pierce-Waller, Inc. does. Technical data sheets are available.

79. Iron Powder—"Hydrogen Reduced Iron Powders" is the title of a technical brochure from Pyron Corp.

continued on next page

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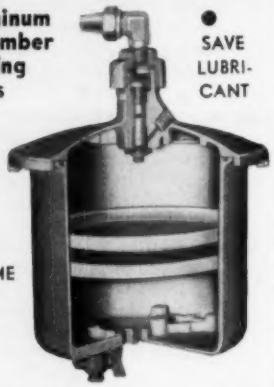
for aluminum cold chamber die casting machines



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- FEWER REJECTS
- INCREASE PLUNGER AND CHAMBER LIFE

- **Write now for literature, full details and prices . . .**

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P.O. Box 231 — St. Joseph 2, Michigan

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continued from page 119

80. Vacuum Die Castings—Literature on vacuum die castings and the Premier Die Casting Company's facilities for producing custom castings to your specifications, is available from the company.

82. Sintering Savings—A technical report, "How To Cut Costs With The Remet Powdered Metal Process", is available from Reese Metal Products Corporation.

83. High Strength Powder—Preliminary impact test data on Type HS6460 is available from Republic Steel Corp.

84. Master-Molds—and cavity blocks, where you shoot in the lower position and mold vertically, are described in engineering data from Richards Tool & Mold Co.

85. Stainless Steel Ladles & Skimmers—which are 75% lighter than cast iron and have extremely long life, are described in technical literature. Spincraft, Inc.

87. Statistical Quality Control—for die castings. Technical literature, from Stroh Die Casting Co., Inc., describes their use of quality control for lower inspection costs.

90. Die Steels—for die castings dies. Technical data sheets are available from Vanadium-Alloys Steel Con. on MC, Speed-Cut, and Hotform die steels.

92. Piston Lubricator—Data folder describes the Dorsey automatic piston and cylinder lubricator for aluminum cold chamber die casting machines. Westbrook Mfg. Co.

93. Finishing—non-ferrous metals is the subject of technical reports from Allied Research Products, Inc.

95. Painting Masks—A 20-page book shows the different types of spray masks offered by Wm. M. Fiore, Inc. Includes case-study illustrations of their use in making precise registration possible.

98. Sinterings—Engineering handbook on powder metallurgy is available from International Powder Metallurgy Co.

99. Design Information—on "self-lubricating metal parts is available in technical literature from Brockway Pressed Metals, Inc.

101. Die Casting Machines—that give up to 1000 shots per hour for small parts, are explained in technical data from DCMT Sales Corp., Div. British Industries Corp.

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SPECIAL HIGH GRADE ZINC — 99.99%

One Fine Zinc For Die Casting

International Minerals and Metals Corp.

11 Broadway
New York 4, N.Y.

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DIE CASTING *by* HOOVER

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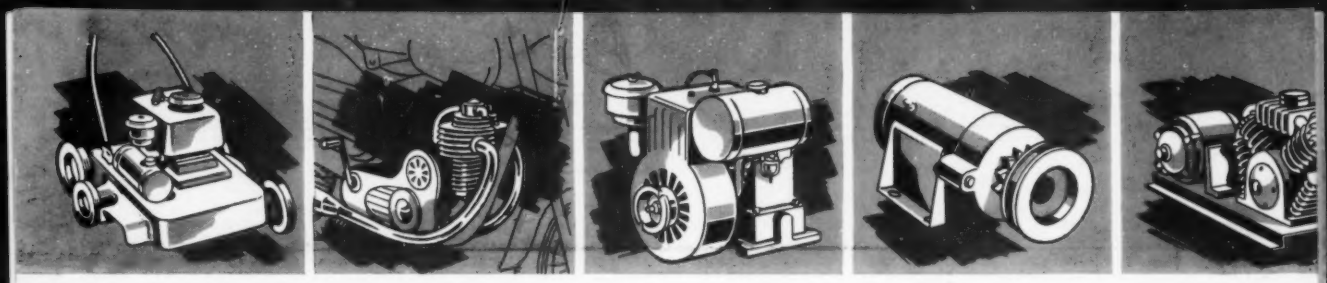

LIGHT, DURABLE ALUMINUM HELPS BUILD MODERN MOTORS

Whether you're mowing the lawn or motor boating, enjoying air conditioning or running a power saw, you are relying on motors—and *aluminum*. The power and efficiency of these mighty units help you perform many tasks better and faster, at considerable saving of energy.

The growing motor-building industry serves you and itself exceedingly well—through aluminum. Lightweight aluminum gives extra ease of handling to motor-equipped appliances, and its ability to resist rust, corrosion, pitting and chipping assures longer, trouble-free life. Aluminum contributes strength wherever it is used, reduces costs as it saves steps in the production process.

Apex Smelting works hand in hand with the builders of modern motors. Apex aluminum alloys, scientifically produced to each manufacturer's exacting requirements, are significant factors in the outstanding performance and quality you enjoy in today's motors.

APEX SMELTING COMPANY

Producers of ALUMINUM, MAGNESIUM AND ZINC ALLOYS

CHICAGO 12 CLEVELAND 5 LONG BEACH 10, CAL.

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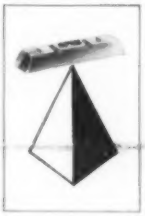

Research leadership back of every ingot

Your products may also be produced better and more efficiently with the help of aluminum castings. Apex Smelting and the companies it serves in the die casting and foundry industry stand ready to assist you and your engineers.